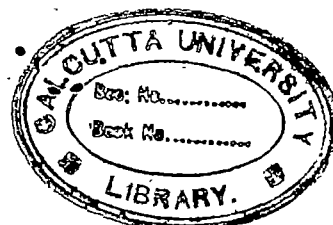


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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

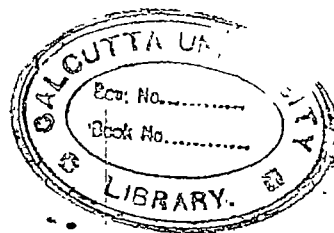
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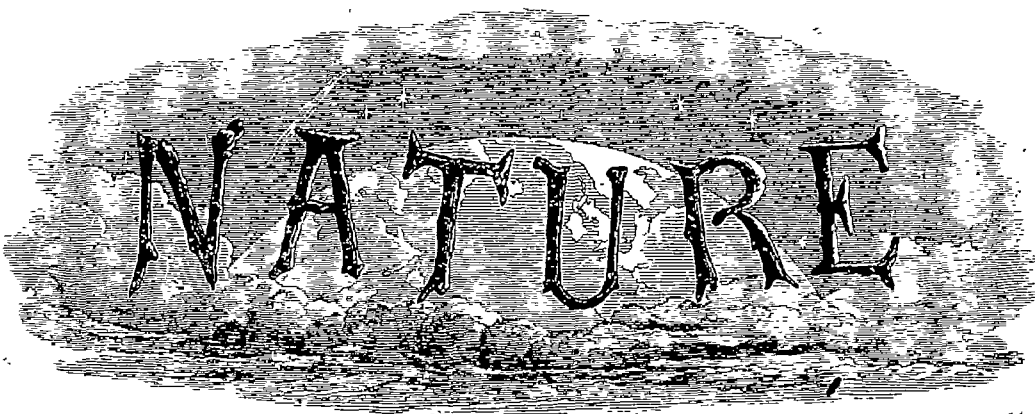
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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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International Science.

ONE of the most important developments of scientific activity during the latter half of the nineteenth century was the promotion of the exchange of scientific ideas between different countries by means of international associations. Some of these were congresses which met at intervals of three or four years, when scientific communications were read and discussed, and, what was of still greater importance, an opportunity was afforded for those engaged in similar studies to make each other's acquaintance and understand each other's point of view. Some associations were, on the other hand, more especially concerned to secure the co-operation of different nationalities in carrying out observations of particular natural occurrences on a uniform plan, or with standardised instruments, so that the results could be discussed as a whole and no portion of the field of work should be entirely neglected.

The outbreak of War in 1914 caused an abrupt interruption to this friendly intercourse, which had up to that time exercised a very favourable influence in the progress of science. On the occasion of previous hostilities, the conclusion of peace was always followed by a renewal of scientific *camaraderie*, but this did not occur after the last and most disastrous of wars. The policy of the High Military Command of the Central European powers in waging war with a rigour previously unknown in modern times had imported unprecedented bitterness into the struggle; moreover, it must be remembered that, for the first time, scientific men themselves were brought into the conflict instead of continuing quietly to work in their laboratories, and maintaining correspondence with those of other nationalities, as was formerly the case. It is not surprising, therefore, that when the War was over many scientific workers in the allied countries hesitated

to renew the relations that had previously existed, even though it seemed scarcely just to make their former scientific colleagues responsible for the conduct of their countries' military chiefs.

The subject was discussed at an Inter-allied Conference of men of science held in London in October 1918, about a month before the Armistice, and resolutions were passed. The most important, Article I, was in the following terms: "It is desirable that the nations at war with the Central Powers withdraw from the existing conventions relating to International Scientific Associations in accordance with the statutes or regulations of such Conventions respectively as soon as circumstances permit, and that new associations deemed to be useful for the progress of science and its applications be established without delay by the nations at war with the Central Powers, with the eventual co-operation of neutral nations."

A further conference was held at Paris towards the end of November 1918, when details were discussed and an executive committee appointed to prepare a scheme. As a result, an International Research Council was convened at Brussels in July of the succeeding year, and definite statutes of convention were adopted. In these the purposes of the International Research Council are declared to be (*inter alia*): (1) To co-ordinate international efforts in the different branches of science and its applications. (2) To initiate the formation of international Associations or Unions deemed to be useful to the progress of Science in accordance with Article I. of the resolutions adopted at the Conference of London, October 1918.

It is the incorporation of Article I. that determines the present character and policy of the International Research Council and the Unions formed under its auspices.

A list is given of the countries "that may participate in the formation of the International Research Council and of any Scientific Union connected with it, or join such Union at a subsequent period." It corresponds to the countries and dominions which were at war with the Central Powers, except that it includes Greece and Poland, and omits Russia and the new Baltic Powers. It then provides that, after a Union or Association is formed, "nations not included in the above list, but fulfilling the conditions of Article I. of the resolutions adopted at the Conference of London, and diplomatic Protectorates of the enumerated countries may be admitted either at their own request or on the proposal of one of the countries already belonging to the Union. . . . A favourable majority of not less than three-quarters of the countries already forming part of the Union shall be required for admission. . . . The statutes of the Unions formed by the International

Research Council require the approval of this Council." Later, Czechoslovakia and a number of neutral countries, including Denmark, Norway, Holland, Sweden, and Switzerland, were invited to join the International Research Council and the scientific organisations attached to it.

As we have seen, the provision for the admittance of new countries refers only to the Unions, not to the Council itself, but it has in practice been assumed to apply to the Council. In an amendment to the constitution proposed by the Executive Committee this has been explicitly provided.

The meetings of the General Assembly are held, as a rule, once in three years. The last meeting was held in 1922, and the next will be on July 7 in the present year. At the meeting in 1922 it was resolved "that only countries which have adhered to the International Research Council are entitled to be members of the Unions connected with it."

The stringency of the exclusion of the men of science of former enemy countries is consistently maintained in the statutes of the Unions formed under the International Research Council. A rule, which is, it is believed, common to them all, provides that "the President of the Executive Committee [of the Union] may invite to a meeting of the General Assembly [of the Union] scientific men who are not delegates, *provided that they are subjects of one of the adhering countries*." It is at the General Assembly of a Union that scientific questions are considered, but no man of science, however eminent, is allowed to join in the discussion, or even to be present, if he belongs to one of the nations with which the Allies were formerly at war,—and this after seven years of peace.

From the first there were many scientific men among the allied nations who objected to these stringent measures of exclusion, and as time passed their numbers have increased. Geology has not only refused to form a Union under the International Research Council, but, at the Congress in Brussels in 1922, adopted an independent constitution, without any provision for excluding subjects of the Central Powers; and a meeting will be held under it in Madrid in 1926. The International Mathematical Congress that was to have been held in the United States in 1924 was abandoned because in that country "neither scientific co-operation nor financial support were in sight for a congress under the rules of the International Research Council." A meeting was, however, held in Canada, when the American Section of the Union passed a resolution requesting the International Research Council to consider whether the time was not ripe for the removal of the restrictions on membership now imposed by the rules of the Council. The London Mathematical Society has

refrained from attending this meeting, as well as that preceding it at Strasbourg.¹

In view of the forthcoming meeting of the International Research Council, the Australian National Research Council has asked that this question shall be reconsidered. The Royal Academies of Science of Holland, Denmark, and Sweden, and the Société Helvétique have definitely purposed to amend the statutes by omitting all references to Article I. of the Resolutions of the Conference of October 1918. This change would, it is presumed, permit any nation to be admitted to the International Research Council and the scientific organisation attached to it on a vote of a majority of not less than three-quarters of the countries already included. Switzerland, however, would, by an additional provision, confine the privilege to countries forming part of the League of Nations.

Holland and Denmark wish, on the other hand, to rescind the provisions of the addition to the statutes in 1922, and thus permit a country to be admitted to a Union without previous admission to the Council. The Executive Committee will not support this proposal, but suggests an amendment, providing that a country which has joined the International Research Council has the right to be admitted to the Unions connected with it.

It is to be hoped that the International Research Council will not maintain the present exclusion of subjects of the former enemy powers; for we believe that this position is opposed to the wishes of the vast majority of the scientific men of the allied countries, and, needless to say, to the unanimous convictions of those of neutral lands.

If the Swiss amendments are carried, no distinction will remain between allies, enemies, or neutrals. The only condition of admittance will be membership of the League of Nations and the vote of the Council. This would permit of the admission of Austria at once. Germany would probably be eligible in a few months, but would have to wait for actual admission until the next General Assembly three years hence, unless of course she could be admitted conditionally on her joining the League of Nations. Russia would presumably be excluded, as she is not likely to join the League.

The simplest course would undoubtedly be to leave the question of admission to the uncontrolled discretion of the International Council, retaining, if it is thought desirable, the necessity of a three-quarters majority for a favourable decision. We are hopeful that the General Assembly at Brussels next week will alter a situation which is both unsatisfactory and unreasonable.

¹ Reference may also be made to the letter on this subject by Prof. G. H. Hardy, president of the National Union of Scientific Workers, published in some leading daily newspapers on May 30, 1924.

College Courses and University Examinations.

A BOLD policy has been adopted by the Senate of the University of London with the view of solving one of the oldest and most difficult questions in relation to the organisation of University education in London—the question of establishing a close association between college courses of study and the examinations for university degrees. The college selected for this experiment is the Imperial College at South Kensington, comprising the Royal College of Science, the Royal School of Mines, and the City and Guilds (Engineering) College. Of these Colleges, the Royal College of Science has always adopted a distinctive method of training its students, based on the intensive study of one subject at a time. The impracticability of completely adjusting the degree examinations of the University to this system of training, conjoined with a general desire on the part of the College for freedom in framing curricula, led to a prolonged and somewhat embittered controversy between the College and the University, in the course of which the College authorities adopted the extreme measure of applying for the status of a separate University. This failed, as other attempts of the kind had previously failed: but the fundamental problem remained unsolved.

The history of the controversy as to relating University examinations to college teaching is as old as the University itself. Established by Royal Charter in 1836 for the purpose of examining for academic degrees students of University College, King's College, and other affiliated colleges, the University in course of time adopted an attitude of aloofness to all colleges, though it was no part of the original conception of the University of London, as the Selborne Commission pointed out, that it should be a mere examining body, without any direct connexion with teaching institutions. In those early days great importance was attached to the independence of the examining authority. University College welcomed the Royal Charter for the University, on the ground that the professors of the College would not have to confer degrees on their own students. There were, however, some connected with the College who raised the objection that the examinations would interfere with the independence of College teaching, both by determining the course of study and by affecting the method of instruction; and the College manifesto admitted that "this argument has weight." It is a tribute to the fairness and efficiency of the University examinations that this objection was not pressed for so many years. In 1884 the "Association for Promoting a Teaching University for London" was formed. This was the

first step leading to the reconstitution of the University of London as a teaching University. The Senate and the Convocation—since shorn of some of its privileges—were not unfriendly to the general idea of a teaching University; and the Senate was even prepared to accept college examinations for pass degrees.

It is of interest to note that the College to which the new scheme is to be applied is the College with which Huxley was connected as dean and professor, and that the policy adopted harmonises with his general views. Huxley had a fine conception of the University which London ought to possess. In his evidence given before the Gresham Commission in 1892—a model for soundness of judgment and clearness of expression—he severely condemned the attempt of University College and King's College to "corner" university education in London. As an alternative to the creation of a separate teaching university, he urged that the title and prestige of the University of London should be retained, and the University reorganised in such a manner as to secure uniformity and efficiency in all university work, with freedom and elasticity. "In short, unify without fettering." As to the conduct of university examinations, he urged the Commission to leave the question quite open. Degree-giving was a subsidiary matter, not an end in itself. While Huxley was in favour of trusting a college to organise and test the training of its students, he considered that some outside control was desirable, because every man has a "list," as they say at sea.

The working of this experiment in relating college teaching to university examinations will be watched with interest, and its success may produce important results throughout the Empire in the direction of greater variety and elasticity in all our educational arrangements. Let us hope, too, that it may tend to reduce the fervour of some of the worshippers of the examination-fetish. The internal results should be not less valuable. The Imperial College has not only closed a barren controversy, but also in the process has been selected for a position of special privilege in the University. *Noblesse oblige*. The University, faced with many other difficult problems, is entitled to the full co-operation of all its affiliated colleges. Only last week the partial failure of the Bloomsbury site scheme was announced by the publication of some uninspired correspondence between the Treasury and the Principal Officer of the University. This partial failure is due to the Government's arranging for the transfer of King's College to Bloomsbury without taking the elementary precaution of ascertaining whether this great College wished to move. The problem of providing a home worthy of the University of the metropolis of the Empire still remains.

T. L. H.

Crop-Production in India.

Crop-Production in India. a Critical Survey of its Problems. By A. Howard. Pp 200 (London: Oxford University Press, 1924) 10s. 6d. net.

IN recent years some of the lustre of what Disraeli in a flamboyant phrase described as "the brightest jewel of the British crown" has been dimmed by political happenings. In the less spectacular sphere of economic improvement it might be said that new facets continue to be added to the jewel. The most rabid of Swaraj fanatics must acknowledge that, if British rule has accomplished nothing else, it has, at least, given their country material benefits in fullest measure. Of these no better example can be found than the achievements of the small band of scientific workers who, during the last twenty years, have been applying scientific methods to Indian agriculture.

The most distinguished of these pioneers sets out the amazing story in the volume before us, and it is one calculated to excite the envy of his scientific colleagues all over the world. He presents a record, not only of scientific achievement, but also of an organisation under which the public support of science is not limited to the grudging provision of doles in aid of scientific research; for in India we see in operation a system of government under which the supreme power, when satisfied that scientific work has been successful, straightway by administrative and legislative measures sets a seal on that work. One example will suffice. Mr. Howard and his colleagues establish that an improved cotton (that is, a plant yielding a better fibre and more of it) cannot be effectively introduced unless steps are taken to prevent cross-fertilisation with inferior varieties; thereupon an Act is passed by the Legislature sanctioning the prohibition of the sowing (say in a district of 2000 square miles) of any variety of cotton other than that prescribed by expert plant breeders. But it must not be thought that peaceful penetration is not practised also. The poor *rayal* of India (whose life has been aptly described as "a long-drawn question between a crop and a crop") is as fully alive to the value of good seed as his fox-hunting cousin in the shires; witness such figures as these. The area under Pusa 4 and Pusa 12 (two of Mr Howard's new wheats) in the United Provinces is now 500,000 acres, and in the North-West Frontier Province 200,000 acres. In the Panjab colonies a new wheat known as Panjab 11 now occupies upwards of 750,000 acres. The achievements of the workers on cotton improvement are equally striking. In the Central Provinces the area under a new variety of this crop, introduced by the Agricultural Department, amounts to 700,000 acres, giving an additional profit to the cultivator of 20s. per acre.

In the case of rice (which in India occupies upwards of 80 million acres) some of the figures are equally astonishing, and the catalogue might be extended; many of the crops grown for fibre (such as jute) and for oil (such as linseed) have also yielded results to the scientific plant breeder.

The chief aim, however, of Mr. Howard's book is not to record economic results, many of which flowed from the application of scientific method rather than from original research. During the course of the work a number of problems requiring solution have been brought to light, and Mr. Howard has endeavoured to "set out these problems in simple language" with the view of securing the active co-operation of the public. (In other words, the days of paternal government are passing and the burden which is laid upon scientific workers in democratically governed countries is fast descending upon India.) The problems presented do not affect India alone. They affect the whole field of current knowledge regarding the soil and the plant. Workers in the sciences related to agriculture in all countries will find much food for thought in these pages.

The men who—as a result of Lord Curzon's enlightened policy—went out to India in 1904, found that their text-book knowledge was of little help; nor was Voelckers' classic report (*circa* 1890) of much assistance; for at that date the rôle of the leguminous plant in enriching the soil was unknown. Incidentally, it was familiar to the Indian *rayat*. The writer well remembers extracting, about that period, from a brown man in a loin-cloth a list of crops that enriched his soil—a catalogue, it proved, of some ten varieties of leguminous plants, ranging from the shrub-like *Cajanus* to the weed-like *Lathyrus*.

Fortunately, this early period almost coincided with the birth of the Cambridge school of genetics, which, under the inspiration of Bateson and his disciples, has done so much to promote the economic welfare of agriculture. No better field than India for the exploitation of such master ideas as those of the "unit character" and "pure line" could have been found, and of these two tools (in contradistinction to what was experienced in more advanced countries) the latter—the pure line conception—has proved the more useful. As Howard, however, so aptly points out, economic plants fall into two very distinct categories from the point of view of the practical outcome of scientific plant breeding. The isolation and economic introduction of pure lines of plants which are normally self-fertilised—such as practically all the cereals—offers no difficulty; the production of a sufficiently diverse F_2 is the only problem. In the case of normally cross-fertilised plants, however, such as cotton (or the Brassicæ), the practical obstacles are serious. As

indicated above, this problem has been partly solved in India by drastic legislation of a type to which the free-born Western would probably never submit. If to free cross-fertilisation self-sterility be added (the clover is an example), the problem of seed production, both scientifically and practically, becomes one of extreme difficulty. As our author points out, "the creation of an improved variety of crop, by itself, is of no practical advantage to the country: it possesses only a potential value. The new variety must be welded into the rural economy before a real economic result can be achieved." It is perhaps one of the most striking features of the Indian achievements that the plant breeders there have studied intensively and successfully this problem of adapting their improvements to rural economics.

To return to the agricultural problems which confront the scientific workers in India: of these the most puzzling, perhaps, is provided by rice, an aquatic plant with no obvious access to added nitrogen. The produce of 10 million acres of this crop has been exported from Burma annually for the last twenty years, and yet the soil shows no signs of diminishing fertility. The problematic source of nitrogen may be fixation by the algae which inhabit the swamps in which rice is grown. Then, as to the source of the oxygen needed by the roots of the plant, we seem to be equally in the dark. Other problems which have arisen may be briefly indicated. The relation between the economic behaviour of crops and their root development is still obscure. Many facts can be instanced to show that a close relation exists between the quality of a crop and the root development of the plant in varying soils; and an equally important connexion appears to exist between root development and susceptibility to disease. The author believes that attacks of disease in economic plants simply indicate faulty cultural methods, a view that seems to find a parallel in some modern ideas as to disease in the human subject. He is identified with extreme views on the importance of soil aeration, but there can be no question that he presents a body of facts which strongly supports his theories on the subject. The whole question of the "gearing" (as he terms it) between the plant and the soil stands in need of thorough investigation in the light of newer knowledge.

The work of Howard, and, may we add, of his equally distinguished wife, may be taken as a model of what is required of research workers in the applied sciences—the practice of pure scientific research coupled with the rare faculty of a steadfast outlook towards the ultimate economic application of the results. These are qualities which should prove of great value in the direction of the all-India cotton research station to which the author has recently been appointed.

A. B. B.

A T

The Literature of Chemical Technology.

Synthetic Organic Compounds. By Dr. S. P. Schotz. Pp. 412. (London: Ernest Benn, Ltd., 1925.) 45s. net.

SEVERAL books have appeared during the past year or so, both in Great Britain and in the United States, which deal with certain special branches of chemistry from the industrial and manufacturing points of view. Without doubt many of these treatises are excellent and constitute well-written and concise accounts of particular types of manufacture. They may be regarded, therefore, as valuable contributions to technological literature, and are comparable in this respect with similar treatises written by experts in one or other of the many sections of scientific chemistry. In each case the author may be supposed to have, not only a far-reaching knowledge of his subject, but also to possess sufficient wisdom, as distinct from knowledge, to enable him to sift the grain from the chaff in the published literature of the subject with which he deals. Nevertheless, even in a clear-cut comparison such as this, the difficulties met with by the two types of author are very different.

The writer of the scientific treatise finds to hand a vast amount of published detail from which to draw his material. Moreover, he can assume, with a reasonable amount of confidence, that the sources on which he relies constitute accurate and truthful records of the experimental work done and the conclusions reached. The fact that they have been issued under the auspices of one or other of the world's scientific societies gives him the right to assume that they have been published without reserve or ulterior motive.

On the other hand, the writer of the technological book, as soon as he passes away from matters of personal knowledge, finds himself beset by many troubles which will require the greatest powers of discrimination to overcome. For example, he will have to draw largely on the patent literature; and chemical patent literature, especially that of certain foreign countries, is in some instances a compilation of experimental data, and conclusions deduced therefrom, often emanating from the imaginations of those patentees who wish to retain some special field for the exercise of their own activities, or who may wish to mislead their competitors. He will also have to use the chemical technological literature published in one or other of the various journals devoted to this subject, and, here again, he will encounter difficulties. This type of literature is on the increase, and already there are many publications catering for the requirements of the works chemist and chemical engineer. In them the letterpress and the illustrations often serve as convenient vehicles for the advertisements which form

the major portions of the periodicals. The illustrations and the advertisements are mostly those of plant, and this is a useful feature for those who wish to keep themselves in touch with the development of engineering chemistry. The letterpress is, however, frequently of the chatty and personal kind, and only a portion of it is devoted to articles and papers on manufacturing processes and reactions. But, in the very nature of things, it is obvious that such contributions can only be written by authors from the outside, because it is unthinkable that any sane manufacturer, or employee of a manufacturer, would be prepared to publish details of plant and processes very rightly regarded as essential to his works practice and prosperity.

Finally, there are the secret matters, researches carried out by the governments of States in the national interest, usually for war purposes both offensive and defensive. It is here that the angels fear to tread and where discrimination will counsel avoidance. The difficulties in these cases embrace both the types mentioned above, since publication implies either that the data is useless or out-of-date, or that the information is supplied with the direct object of creating a false impression and of misleading a possible enemy. It is evident that no State, however altruistic in outward appearance, would allow any matter of real importance in relation to its war activities to be published, and any chemist doing such a thing from sure knowledge would, in Great Britain, soon fall foul of the Official Secrets Act.

It is therefore clear that the way of the author of the technological book is, indeed, hard, even when he confines himself to some particular branch of his subject with which he has special acquaintance. What then is to be said of a book, such as that under review, which purports to cover the wide field of synthetic organic chemistry, a field with which no human being could possibly have intimate personal knowledge even on the scientific side alone?

It is not suggested that the author has not attempted to carry out his Herculean task with courage and ability. The book has entailed the exercise of great industry and skill in its compilation, and it is evident that the author possesses a wide knowledge of the many intricate subjects with which he deals. It is readable, and the printing and paper leave nothing to be desired. It contains a great deal of information which will be useful to the general reader, although some of the statements made may anger the expert. One general criticism that could be raised is that the formulæ are too elaborate and the frequent use of the benzene ring wholly unnecessary. It is, for example, a shocking waste of the excellent paper to print the formulæ of the phenol-formaldehyde resins on pp. 384, 386, and 387. These formulæ are not based on any single shred

of scientific evidence, and are, indeed, in the highest degree unlikely. The illustrations of plant are admirable, and will serve as excellent advertisements for the firms supplying them. Indeed, it is evident that they are intended as such, because the "Bakeliser" (Fig. 109, p. 372) is also reproduced in the advertisement pages at the end of the book, and when this is not the case, the name of the firm supplying the apparatus appears under the illustration. The plants of the various processes described are also reproduced clearly.

The reviewer has, therefore, no quarrel with the author, but, on the contrary, congratulates him on having accomplished a very difficult task with commendable ability. It is rather the object and utility of the book that he calls in question. As a scientific treatise it is of little value, and as a technological handbook it is in many respects misleading. The statements made, for example, in the article on chemical warfare will bring a smile to the lips of those who have inside knowledge of this subject.

With what, then, are we dealing, and to what kind of reader is the book likely to appeal? It is, as already stated, readable, and will doubtless interest a number of people who take their chemistry lightly and superficially; but, if this were intended, it is surely unnecessary to have included the complex descriptions of intricate organic reactions which only the expert can follow. It may be intended to appeal to manufacturers and to chemists engaged in industrial work, and here again material will be found which will be of interest and general utility, although, if the chemist happens to meet a description of any method of which he has special knowledge, he is not likely to place much reliance on the accounts of other processes. In effect, therefore, the book will appeal to a number of various types of people who may wish to acquire a superficial and incomplete knowledge of many of the operations now carried out in modern organic chemical manufacture and are not in a position to be hypercritical of the information they receive. Doubtless there are several of these, since this is only one of the many books of its kind which have been published and, we understand, are about to be published, and it is only reasonable to suppose that their production pays.

Moreover, there can be no question that books of this kind serve a useful purpose in popularising science, and in bringing home to many people the achievements which the modern development of scientific industrial methods have accomplished in supplying them with some of the present-day requirements of life. The only doubt in the present instance is whether the author has supplied sufficient jam to mask his very large pill and to make it palatable to the general reader.

J. F. T.

The Electrical Theory of Matter.

Handbuch der Radiologie. Herausgegeben von Prof. Dr. Erich Marx. Band 6: Die Theorien der Radiologie. Bearbeitet von M. Laue, P. Zeeman, H. A. Lorentz, A. Sommerfeld und G. Wentzel, Georg Joos, E. Riecke, L. Vegard, P. Debye. Pp. xi+806. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1925.) 40 gold marks.

THERE exists scarcely any branch of science which is not indebted to Germany, not only for important original contributions to its progress, but also for the publication of excellent and comprehensive treatises. With the appearance of this sixth volume, another of these so-called handbooks reaches completion. It is now some years since the last of the previous volumes was published, and it is evident, from the remarks made by the general editor, Dr. Marx, that this volume has only reached completion after much delay and the surmounting of many difficulties. That this should be so is scarcely surprising. From the theoretical point of view, modern physics is in a peculiar position. The two rival theories—the older classical theory and the more modern quantum hypothesis—have each met with marked success in interpreting observed results, but we are still very much in the dark as to the real connexion between the two. Where one fails the other as often as not succeeds. We must therefore be prepared, in such a volume as this, to find, not so much a logical development, but rather a series of attempts at correlating observed phenomena in terms of one or other of the two main lines of thought; and this indeed we actually find.

To do justice in small space to a volume of this magnitude, dealing with mathematical theory and coming from the pens of seven separate authors, is clearly impossible. Fortunately, with such names as Lorentz, Laue, Sommerfeld, Debye, and others on the title-page, there is little room for doubt as to the quality of the contents. From such authors we know what to expect, and a closer inspection does not disappoint us. The previous volumes dealt essentially with the more experimental side of modern physics, and it was intended to devote the final volume to a discussion of its purely theoretical aspects. While this plan has been to a large extent adhered to, the reader will find a pleasant variation in the few chapters which deal with experimental results in fields which have not been covered in the previous volumes. Notable in this connexion are the excellent account of the Zeeman effect and Dr. Joos's summary of the results of work on ionisation potentials.

The volume opens with a discussion of the motion of a free electron in various types of electric and magnetic

fields; after a very full treatment of this question, Prof. von Laue proceeds to consider the problems of conduction through gases and the passage of α and β particles through matter. The discussion of the motion of the free electron is naturally followed by an account of the motions of electrons in the atomic field and of the way in which these may be influenced by external forces. A most lucid description of the magnetic separation of spectral lines comes, as is only fitting, from Prof. Zeeman, whose name the phenomenon bears. That the theory of the effect should be contributed by Prof. Lorentz is also most appropriate, since it was he who first put forward a quantitative explanation of the influence of a magnetic field on the spectrum. The abandonment of the original theory based on the classical mechanics in favour of one founded on the quantum hypothesis is an example of what has taken place in many branches of physics. A general account of the origin of optical spectra on the basis of the Bohr atom is developed by Prof. Sommerfeld and Dr. Wentzel. Prof. Sommerfeld's work on this subject is so well known and so widely appreciated that there is no need to dwell on the merits of this section. The summary by Dr. Joos, dealing with ionisation potentials and the conditions for the excitation of spectra, forms a suitable conclusion to the treatment of atomic radiation.

A long and detailed account of the electrical theory of the solid state, dealing notably with such problems as electric and thermal conductivity, was contributed by the late Prof. Riecke. As a considerable period has elapsed since this section was written, it has been copiously annotated by Prof. Laue in order to bring what is a very thorough discussion up-to-date.

One of the most readable sections is that on the aurora by Prof. Vegard. It is a subject that the author has made peculiarly his own, and his description of the observed facts and the theory are full of points of interest. Some of his conclusions have recently been questioned, especially his explanation of the source of the famous green line; but whether or not his theory will require modification, it has already achieved one of the main objects of any theory in suggesting a new field of research in the study of the spectra emitted by matter at extremely low temperatures when bombarded by electrons.

The final chapters, written by Prof. Debye, are devoted to the theory of the electrical and magnetic properties of molecules. The subject is one of great complexity, and it is impossible not to admire the way in which it has been treated. The subject of magnetism has perhaps scarcely kept pace with the progress which has been made of recent years in other branches of physics, but signs are not wanting that the near future will see a rapid development. Prof. Debye's account, written

in his extremely lucid style, indicates some of the lines along which we may expect progress.

The editor and his collaborators are to be congratulated on the completion of the "Handbook of Radiology." This final volume will prove invaluable to all students of modern physical theory, inasmuch as it gives full discussions, with extensive references to original papers, of a wide range of subjects, many of which have not so far received adequate treatment in text-book form. The book is full of indications of probable lines of advance, and in this respect will make an appeal not only to the theorist but also to the experimental worker.

Digitalis in Medicine.

The Action and Uses in Medicine of Digitalis and its Allies. By Prof. Arthur R. Cushny. Pp. xi+303. (London: Longmans, Green and Co., 1925.) 18s. net.

OUR knowledge of the action of digitalis on the heart was founded by William Withering, of Birmingham, whose classical treatise was published in 1785. Since that time, owing to the multiplicity and scope of the researches of an ever-increasing number of workers, the literature of the subject has reached such proportions that an attempt to collect together and analyse the results achieved appears already overdue. Prof. Cushny has undertaken this arduous task in compiling the monograph under notice, in which the knowledge acquired during thirty years of personal research is embodied in a critical account of the whole subject, from the time when digitalis was first employed in heart disease up to the present day.

The book opens with an account of the various drugs of the digitalis group and their histories. It is not certain when digitalis first came into medical use, but it was known long before Withering's time; and the English term "foxglove" may bear some allusion to Fuchsius of Tubingen, who described it in 1542 as an emmenagogue. Apart from digitalis, many of these drugs were originally employed as arrow poisons, and for the purpose of trial by ordeal, by the natives of Africa and the Malayan Archipelago. A detailed account is given of the action of digitalis on the frog's heart, illustrated by numerous graphic records of the heart movements. The reaction of the mammalian heart to digitalis, as seen in animal experiment, is similarly dealt with. Some conception of the scope of the laboratory investigation is gained when we are told that the effect of digitalis or allied drugs on the heart is known in the cases of the frog, toad, grass snake, green lizard, rat, tortoise, crab, crayfish, lobster, snail, newt, tadpole and embryonic chick, among others.

Pigeons are relatively susceptible to the drug, rats and toads tolerant, while man is more susceptible, weight for weight, than animals.

In Chapter vi. the author discusses at length the action of digitalis on the blood pressure. Blake's discovery in 1839 that a rise in arterial tension was produced in animals by large doses of digitalis gave rise to a controversy over its action in man which has persisted almost up to the present day, although Sahli showed in 1901 that this result did not follow therapeutic doses. Prof. Cushny holds it proved that this rise in blood pressure seen in animals is due mainly to constriction of the vessels, but he emphasises the fact that there is no evidence of a similar effect being brought about in man by medicinal doses of the drug. No doctrine has died harder among medical men than the belief that digitalis is dangerous in cases of high blood pressure, but it is to be hoped that this has now been finally banished from medical teaching.

After a description of the effects of digitalis on organs other than the heart, its absorption, elimination, and cumulative action, seventy pages are devoted to therapeutics. Withering's knowledge of digitalis was the outcome of ten years' clinical observation in his practice, and although his work was followed by such a vast amount of research in animals, no real advance in the clinical use of the drug can be said to have occurred until more than a century later, when Sir James Mackenzie discovered its almost specific action in cases of auricular fibrillation, again as the result of clinical observation. In the case of abnormal heart rhythms the mechanism of the action of digitalis is now well understood, but we are still unable to account for its variable and uncertain effect in cases of normal rhythm. On this obscurity Prof. Cushny is unable to throw any new light, but we gather that he regards the direct action on the heart muscle, increasing the force of the contraction, as a more important factor than the reduction in rate in bringing about the undoubted clinical improvement which sometimes follows digitalis administration in these cases. At present this cannot be accepted as proved, and it is here that future researches may be expected to add to our knowledge. In pneumonia the author believes that digitalis can effect the heart beneficially, but he is unable to arrive at any definite indications for giving the drug, and does not advise its routine use in this disease.

The effect of digitalis on the electro-cardiogram is described, and we are somewhat surprised to find that Prof. Cushny attaches so little significance to the flattening and inversion of the T-wave which is such a constant effect of adequate doses of the drug in practice. The book concludes with a description of the various preparations of digitalis and the methods used in their

assay. A bibliography of 559 references to the literature is placed at the end of the book.

A treatise of this nature, covering the ground of both laboratory research and clinical practice, and coming from such an authority as Prof. Cushny, who has himself played no small part in the development of the subject, is an invaluable addition to the literature of digitalis. Moreover, the book affords the reader ample opportunity for studying the relationship of animal experiment to practical medicine. The fact that the reaction of healthy animals to poisonous doses of a drug may differ widely from the effects of medicinal doses on diseased mankind has not always been sufficiently appreciated in the past, mainly perhaps owing to the tendency of the laboratory worker to become too isolated from the clinician. The advantages of close co-operation between laboratory and clinic are nowhere better illustrated than in this admirable account of the work which has transformed digitalis, once an old country remedy for dropsy, into what may be justly described as one of the best-mapped regions of therapeutics.

Our Bookshelf.

Monographs of the Geological Department of the Hunterian Museum, Glasgow University. 1. *The Collection of Fossils and Rocks from Somaliland.* Made by B. K. N. Wyllie and Dr. W. R. Smellie. Pp. vi + 180 + 18 plates. (Glasgow: Jackson, Wyllie and Co., 1925.) 42s. net.

THIS work deals mainly with the palæontology of the Jurassic, Eocene, and Oligocene deposits of part of the maritime plain of British Somaliland in the neighbourhood of Bulhar and Berbera (Gulf of Aden), and is based on the collections made by Messrs. Wyllie and Smellie when surveying the region on behalf of the Anglo-Persian Oil Company. It is to be hoped that other companies will adopt this policy of allowing matter of geological interest to be published. The collection has been presented to the Glasgow University Museum.

A summary of the geology of the district is given by B. K. N. Wyllie, based on the joint work of himself and Dr. Smellie, but petroleum is not mentioned. The palæontology is the work of R. B. Newton (Foraminifera and Nautilus), J. W. Gregory (Corals), E. D. Currie (Echinoidea), J. Weir (Brachiopoda and Mollusca), and L. F. Spath (Ammonites). A short account of the igneous rocks is given by A. T. Neilson.

The Jurassic deposits consist of (1) a lower series, the Bihin Limestone, 1000 feet thick, of which the age is not precisely determined but appears to range from Bathonian to Oxfordian. The corals and echinoids are unlike those of Cutch but have affinities with European faunas of similar age, from which it is inferred that the Somaliland sea had no direct connexion with that of western India but must have been a gulf from the Mediterranean. (2) The upper series, known as the Meragalleh limestone, 2300 feet in thickness, is shown

by the ammonites to be mainly Kimeridgian but possibly extending into Tithonian and Infravalanginian. The differences between the ammonite faunas of Somaliland and other regions are regarded by Spath as due to differences of age rather than to difference of facies or geographical province.

The beds of Eocene age consist of limestones and sandstones containing corals, echinoids, lamellibranchs, Nautilus, etc. At about the middle some 2000 feet of gypsum and anhydrite occur, indicating that part of the sea became isolated and underwent intense evaporation. The Oligocene limestone is regarded as of Aquitanian age and contains calcareous algæ, foraminifera, corals, etc. The corals resemble those of the Tongrian of northern Italy, Austria, and the West Indies. The absence of Miocene and Pliocene deposits suggests that the Gulf of Aden was not covered by sea until the end of Pliocene times, a little earlier than the date of the raised coral reefs.

It is unfortunate that in many cases the figures of the fossils are unsatisfactory. Some of the specimens were evidently unsuitable for illustration by photographic means and their characteristics cannot be made out.

Researches on Fungi. By Dr. A. H. Reginald Buller. Vol. 3: The Production and Liberation of Spores in Hymenomycetes and Uredineæ. Pp. xii+611. (London: Longmans, Green and Co., 1924.) 30s. net.

It is a pleasure to welcome the third volume of Dr. Buller's researches into the production and liberation of spores in the fungi, the second volume of which was noticed in NATURE of October 27, 1923, p. 614. The delicacy of technique, the minuteness and exactness of the observations, and the assiduousness in the elucidation of abstruse details so characteristic of the first two volumes are well maintained in the present work.

In Part I. the author continues his observations on the mechanisms of spore dispersal in the Agaricineæ. He distinguishes two main types of organisation for the production and liberation of spores: (1) *Æquihymeniferæ*, with thick wedge-shaped gills, not afterwards destroyed by autodigestion, and (2) *Inæquihymeniferæ*, with thin parallel-sided gills, afterwards autodigested from below upwards. In the first five chapters the fruit mechanisms of sub-types of the first group are described, e.g. *Lepiota*, *Bolbitius*, *Armillaria*. Most of the remainder of Part I. deals with sub-types of the second group, as exemplified by species of *Coprinus*. Some interesting material on the bilumenescence of *Panus*, and the parasitism of *Agarics* on *Agaric* hosts, is also introduced. Part II. of the volume takes up the production and liberation of basidiospores in the Uredineæ. Dr. Buller finds the essentials of spore dispersal similar to those of the Hymenomycetes. In this case, however, the spores are larger and are shot to a greater distance. Some teleological but none the less interesting correlations are given regarding the curvature of the basidium in Uredineæ, and the straight form found in most Hymenomycetes. As in the first two volumes, the book is profusely illustrated with interesting photographs and many of the author's fine drawings. J. E.

Offa's Dyke. By J. H. Hewlett. Pp. 32+8 plates. (London: Simpkin, Marshall and Co., Ltd., f.d.) 3s. 6d. net.

FOR some time past it has been evident that public interest in archæological discovery has been on the increase, and that this interest has extended to sites of historic and prehistoric importance is to some extent borne out by the protests aroused some two years ago by the threat to interfere with the amenities of Stonehenge. Mr. Hewlett's description of Offa's Dyke is a book which is welcome on this account. The more well-informed the public is about the antiquities of the countryside, the better chance of the avoidance of wanton damage. Mr. Hewlett has divided his account of this interesting defensive work into five sections. In the first, he gives a general description of the dyke; in the second, he traces its course and offers suggestions as to its line where it has now disappeared; in the third, he describes the country through which it passes; in part four he discusses the theories of its purpose; and in the fifth, gives the main facts connected with the life of Ossa. As to its original place of termination in Flintshire, which is still a problem, Mr. Hewlett states the theories which have been put forward, but himself has no solution to offer, although he is of the opinion that it is Wat's Dyke and not Offa's Dyke which ends at Basingwirke, notwithstanding the occurrence along this line of place-names such as Plas Offa, Bryn Offa, and Clawdd Offa (Offa Dyke).

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. Abteilung 2, Teil 2: Bryophyten. Band VII/1: Anatomie der Lebermoose. Von Prof. Dr. Th. Herzog. Pp. iv+112. (Berlin: Gebrüder Borntraeger, 1925.) 8.70 gold marks.

DR. TH. HERZOG has produced a monograph of 108 pages with ninety-three text figures upon the anatomy of the liverworts, and in this space it would appear possible to give a very complete report of progress in this very specialised field. There is, however, no mention of mycorrhiza, and some important American work is not discussed. The work is divided into three sections. In the first there is a description of the various types of differentiated cell reported in the group, and it is striking how frequently these differentiated elements are to be found in thalloid forms. This section is followed by two further sections, dealing with the anatomy of gametophyte and sporophyte respectively, in which each group of the liverworts is passed in review in turn.

Introduction to Modern Political Theory. By C. E. M. Joad. (The World's Manuals.) Pp. 127. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 2s. 6d. net.

THIS short manual gives an excellent and clear account of the various socialistic and communistic theories which have recently become important owing to the success of the revolutionary movement in Russia. Mr. Joad takes naturally to this kind of work and is peculiarly well fitted for it. He can write sympathetically without the loss of balance which spoils the work of the propagandist.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this, or any other part of NATURE. No notice is taken of anonymous communications.]

The Taungs Skull.

THE account which Prof. Dart published of the Taungs skull (NATURE, Feb. 7, p. 195) left many of us in doubt as to the true status of the animal of which it had formed part, and we preferred, before coming to a decision, to await an examination of the fossil remains, or failing such an opportunity, to study exact casts of them. For some reason, which has not been made clear, students of fossil man have not been given an opportunity of purchasing these casts; if they wish to study them they must visit Wembley and peer at them in a glass case which has been given a place in the South African pavilion.

The chief point which awaited decision relates to the position which must be assigned in the animal kingdom to this newly discovered form of primate. Prof. Dart, in writing of it, has used the name of anthropoid ape; he has described it as representing "an extinct race of apes intermediate between living anthropoids and man"—which is tantamount to saying that at Taungs there has been discovered the form of being usually spoken of as the "missing link." That this is his real decision is evident from the fact that he speaks of it as "ultrasimian and prehuman" and proposes the creation of a new family for its reception.

An examination of the casts exhibited at Wembley will satisfy zoologists that this claim is preposterous. The skull is that of a young anthropoid ape—one which was in the fourth year of growth—a child—and showing so many points of affinity with the two living African anthropoids—the gorilla and chimpanzee—that there cannot be a moment's hesitation in placing the fossil form in this living group. At the most it represents a genus in the Gorilla-Chimpanzee group. It is true that it shows in the development of its jaws and face a refinement which is not met with in young gorillas and chimpanzees at a corresponding age. In these respects it does show human-like traits. It is true that it is markedly narrow-headed while the other African anthropoids are broad-headed—but we find the same kind of difference in human beings of closely allied races. Prof. Dart claimed that the brain showed certain definite human traits. This depends upon whether or not he had correctly identified the position of a certain fissure of the brain—the parallel fissure. In the show-case at Wembley a drawing is placed side by side with the "brain cast"; but when we examine the brain cast at the site where the fissure is shown on the drawing, we find only a broken surface where identification becomes a matter of guess-work.

In every essential respect the Taungs skull is that of a young anthropoid ape, possessing a brain which, in point of size, is actually smaller than that of a gorilla of a corresponding age. Only in the lesser development of teeth, jaws, and bony structures connected with mastication can it claim a greater degree of humanity than the gorilla. Its first permanent molar teeth which have just cut are only slightly smaller than those of the gorilla, while the preparations which are being made in the face for the upper permanent canines show that these teeth were to be of the large anthropoid kind.

The other point on which we awaited information

related to the geological age of the Taungs skull. Fortunately, Dr. Robert Broom (NATURE, April 18, p. 569) has thrown a welcome light on this matter. The skull was blasted out of a cave which had become filled up by sand washed in from the Kalahari. The fossil baboons found in neighbouring caves differ in only minor structural details from baboons still living in South Africa. In Dr. Broom's opinion the Taungs skull is of recent geological date; it is not older than the Pleistocene; he thinks it probable that it may not be older than the fossil human skull found in a limestone cave at Broken Hills, Rhodesia. It is quite possible—nay, even probable—that the Taungs anthropoid and Rhodesian man were contemporaries. Students of man's evolution have sufficient evidence to justify them in supposing that the phylum of man had separated from that of anthropoid apes early in the Miocene period. The Taungs ape is much too late in the scale of time to have any place in man's ancestry.

In a large diagram, placed in the show-case at Wembley, Prof. Dart gives his final conception of the place occupied by the Taungs ape in the scale of man's evolution. He makes it the foundation stone of the human family tree. From the "African Ape Ancestors, typified by the Taungs Infant," Pithecanthropus, Plitdown man, Rhodesian man, and African races radiate off. A genealogist would make an identical mistake were he to claim a modern Sussex peasant as the ancestor of William the Conqueror.

In the show-case at Wembley plastic reconstructions are exhibited in order that visitors may form some conception of what the young Taungs Ape looked like in life. Although the skull is anthropoid, it has been marked by a "make-up" into which there have been incorporated many human characters. It is true the ears are those of the chimpanzee, but the forehead is smooth and rounded, the hair of the scalp is sleek and parted; the bushy eyebrows are those of a man at fifty-five or sixty; the neck is fat, thick, and full—extending from chin to occiput. In modelling the nose, gorilla lines have been followed, whereas the nasal part of the skull imitates closely chimpanzee characters. The mouth is wide, with a smile at each corner.

Prof. Dart has made a discovery of great importance, and the last thing I want to do is to detract from it. He has shown that anthropoid apes had extended, during the Pleistocene period, right into South Africa—into a land where anthropoid apes could not gain a livelihood to-day. He has found an extinct relative of the chimpanzee and gorilla but one with more man-like features than are possessed by either of these. His discovery throws light on the history of anthropoid apes but not on that of man. Java-man (Pithecanthropus) still remains the only known link between man and ape, and this extinct type lies on the human side of the gap

ARTHUR KEITH.

June 22.

Spectroscopic Evidence of J-Transformation of X-rays.

IN a recent letter to NATURE (April 25) Messrs. Khastgir and Watson have given some graphical tables where the wave-lengths of the X-ray line *K* are plotted against the atomic number of the elements Nos. 48-60. In these curves there are two discontinuities at *Z* 52 and at *Z* 56, which the authors ascribe to the supposed *J*-transformation of Barkla. The authors state as follows (p. 605): "This seems to be the first spectroscopic evidence of the *J*-transformation."

The curves are said to represent the results of my measurements of the K wave-lengths. Several of the values, however, are *not* those found in my laboratory, but seem to be taken from different, and not very concordant, measurements. For example, the element Cs (55) had never been published in any paper from my laboratory at the time when the letter by Messrs Khastgir and Watson was written.

The K -series of the elements in question had been measured in my laboratory once by Dr. Malmer in the earliest days of X-ray spectroscopy (1914-15). His measurements give no evidence of such a sudden change in the slope of the curve as shown in the letter of Messrs Khastgir and Watson. As these values were obtained with a simple, and not very accurate, method, there are accidental errors of the magnitude 0.005 Å.U. In the *Phil. Mag.* for

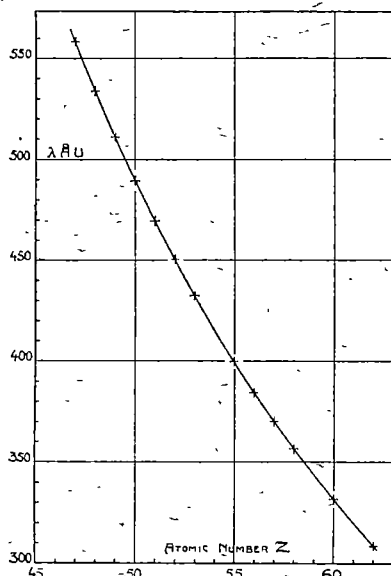


FIG. 1.

November 1919, Dr. Leide and the author described a new method and an instrument by which more accurate measurements could be obtained in this region of wave-lengths. Dr. Leide, who has been working with this apparatus, has just published the results in his dissertation (Lund: Gleerup; and some previous results of his investigation were given in my book, "X-ray Spectroscopy"). His values, which ought to be about 100 times as accurate as those mentioned above, are as follows:

Z.	$K\alpha_1 \lambda \text{ Å.U.}$	Z.	$K\alpha_1 \lambda \text{ Å.U.}$
47	0.55821	55	0.39959
48	0.53386	56	0.38445
49	0.51103	57	0.37004
50	0.48948	58	0.35647
51	0.46931	59	0.34325
52	0.45037	60	0.33125
53	0.43249	61	0.31933
54	..	62	0.30833

In the diagram the wave-lengths are plotted against the atomic number Z .

No trace of such discontinuities as described by Messrs. Khastgir and Watson is to be seen.

MANNE SIEGBAHN.

Physical Laboratory, University, Upsala,
May 30.

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In a recent number of NATURE (April 25, pp. 604-605) there is a letter by Khastgir and Watson describing what is apparently spectroscopic evidence of J -transformation of X-rays. It is the purpose of this note to direct attention to data of more recent date which would indicate that these so-called evidences are caused by experimental inaccuracies in determining the wave-lengths of X-ray emission spectra.

It appears from the graph of Khastgir and Watson

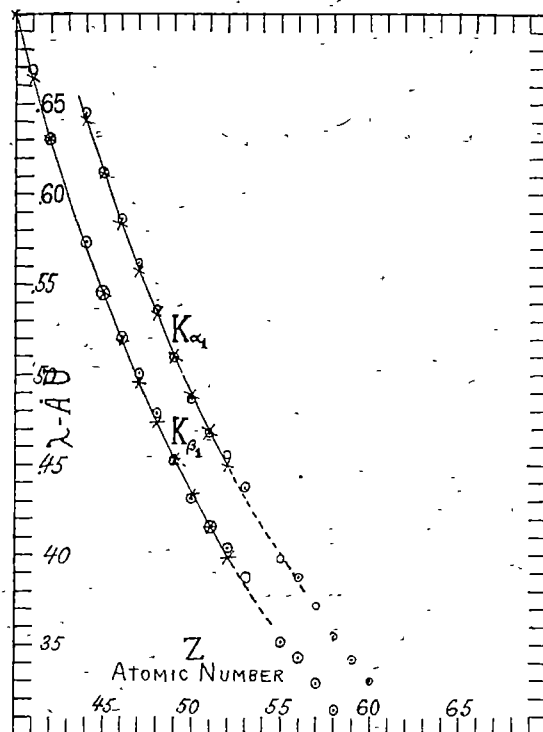


FIG. 1.

that they used values of λ which were determined by Malmer in 1915 (tabulated in "Atomic Structure" by Sommerfeld, p. 153). Siegbahn ("Spektroskopie der Röntgenstrahlen," 1924, pp. 101-102), however, gives values of λ which in some cases are quite different from those of Malmer. I have plotted the values of λ according to Siegbahn's latest work against the atomic number and find that the points fall on a smooth curve, and that there are absolutely no discontinuities. These points are indicated by crosses in the accompanying diagram (Fig. 1). The dots with circles around them indicate the values due to Malmer. Both the $K\alpha$ and $K\beta$ lines are shown in the plot.

It would seem, therefore, that Khastgir and Watson have been led into error by experimental inaccuracies and the peculiar coincidence that the greatest deviation from more recent wave-length determinations occurred at points which correspond with two of the critical absorptibilities for J -transformation. There is, therefore, no spectroscopic evidence of the so-called J -transformation of X-rays.

W. W. NIPPER.

Washington University,
Saint Louis,
Missouri,
May 19.

The Conditions for Calcareous Metabolism in Oysters and other Marine Animals.

THE summer of 1924 was remarkable for an unusually large and heavy growth of the shell of native oysters on most beds in England. In a recent survey of the Fal Estuary oyster beds, full details of which it is hoped will be published later, it was found that a total shoot (*i.e.* maximum increase in height or depth of a shell in a ventral difection) of 30 or more millimetres was quite common. Similar large shoots have been observed in shells from East Coast and other beds in 1924. The fact that the summer of 1924 was not a warm one is a matter of common knowledge and of great interest in connexion with the unusual shell-growth. In warm summers, such as we had in 1921, a big growth of shell is usual, but is then attributed to the generally increased metabolism following upon a high temperature, when biological conditions are otherwise satisfactory; but the rate of shell-growth of the oyster (*i.e.* increase in shell-area, and total increase in shell-weight) under any continuously known conditions is still undetermined. It is, therefore, not possible to state what are the precise conditions which are essential for normal or abnormal shell-growth. These conditions, like those in many other problems relating to the oyster, may not be determined until greater concerted attention can be given to what is admittedly a valuable mollusc. In the meantime it may be worth while to summarise a few observations on the subject.

Most lamellibranchs increase the area of the shell by the repeated addition of small concentric deposits at the edge. The oyster, however, makes a relatively large more or less concentric deposit of thin shell at one operation; this thin deposit, called a shoot, quickly hardens by being thickened.

Good practical oyster-producers say that two of such shoots are frequent in a fair year of growth, and the radius of each such shoot in a 2- to 3-inch oyster may be about 10 mm. This year on the Fal 3 and 4 such shoots, all with practical but not absolute certainty this year's growth, may be found. The variability in the number of shoots laid down from year to year is the main cause of the difficulty or impossibility of estimating the age of young oysters, without very intimate local knowledge of the growth-features. In an average year of growth it would appear that the two usual shoots are laid down in the spring and autumn, that is, on either side of the warm—and also spawning—period. But growth ceases in winter for an undefined period, even on beds such as those off Whitstable (in 1920-21 for example) where abundant food is available. Moreover the present writer has shown that oysters taken from the beds in *winter* and kept under warm conditions, even in practically sterile (Berkefeldt-filtered) water, will grow shell (See Fish. Invest. 2, VI, 3, pp. 43-44—owing to the demands of economy it was only possible to give the bare observations in that paper.) Further, oysters kept in the laboratory in summer will lay down shell automatically in the practical absence of food (see NATURE, vol. III, p. 14). These facts point to a controlling factor represented by a minimum temperature, below which shell is not or cannot be laid down, and above which shell-material may be produced automatically.

There is no doubt that lamellibranchs in general at our latitudes resemble the oyster in their physiological reactions with regard to shell-growth, one example of which is shown by the writer for the cockle, in NATURE, vol. III, p. 147, Fig. 2. If, therefore, calcareous material be only laid down with difficulty at low temperatures, it would be highly instructive to have chemical analyses of those thin-shelled forms which

are found in polar and deep-sea waters. Indeed a deposition of calcareous material by living marine organisms, although made so easily in the tropics, appears to be found increasingly difficult as the habitat becomes colder. One is tempted, therefore, to inquire what may be the chemical composition of the vertebræ or any bony parts of polar and deep-sea fishes. There is a fundamental similarity in living animals which warrants such an inquiry.

It may be noted in passing that the secretion of siliceous matter can be effected at very low temperatures by polar and deep-sea organisms, in some of which it is possible that deposition of silica may replace that of calcareous material.

In the good shell-growth of warm and relatively cold wet seasons, in Great Britain the corresponding hydrographical conditions are respectively high estuarine salinities, alkalinities, and temperatures, and low fluctuating salinities with medium temperatures and (probably) alkalinities; in the wetter seasons one would also expect a smaller amount of available food-material. An explanation of growth which meets the facts partially may be given as follows: shell-deposition in a warm summer is rapid, and any arrest of growth which may be due to breeding is masked, while in the wet summer, growth occurs continuously in the medium temperature and low salinity and is only slightly arrested by the generally—but not totally—repressed reproductive phases. Shell-growth may occur in the pre-spawning period of females, *i.e.* in the spring, but requires to be observed more fully in marked individuals in the post-spawning period, in which there is a suspicion of a slowing down of the operation.

The good shell-growth in the summer of 1924 may, therefore, be understood if we assume that repression of the reproductive capacities in the relatively cold summer permitted continuous growth, which was apparently accelerated by the low salinity. The arrest of growth when reproduction is possible in invertebrates is indicated in the diminutive size of the breeding individuals in the summer crops of the sponges, *Grantia* and *Sycon*, and the very large size possible in the non-breeding wintering forms of the same genera. There is therefore nothing unreasonable in the explanation of growth so far offered. There is, however, another important type of growth which seems to require a different explanation, namely, that which appears to follow removal of oysters to a fresh habitat. For this type of growth a supposition of a general increase in the well-being of the animal does not seem to be sufficient, nor for the fact that an unusual amount of growth occurred in many stunted forms in the Fal Estuary last summer, except that the low salinities, which can be predicted as a result of the heavy rainfall, would be equivalent to a change of habitat. In this respect it is important to note that in the oyster, and doubtless also in related forms, growth does not necessarily follow a mere accumulation of reserve products, as is shown by the fact that "dumpy" (stunted) oysters, which may constitute 40 or more per cent. of a population, were this year on the Fal mostly very well fished (full of reserve products), while the fast-grown oysters were mostly thin and emaciated as though expended in their efforts in growing. Some biological factor appears to shut down the shell-producing mechanism in certain individuals, while in others automatic response to the environment is clearly very prompt. The problem here denoted once more presents the dual interests of science and economics, the boundaries of which cannot be universally defined. J. H. ORTON.

Marine Biological Laboratory,
Plymouth, June 5.

The Isotope Effect in the Spectrum of Silicon Nitride.

RESULTS of a quantum theory analysis of the SiN bands and of the vibrational isotope effect in these bands were given in an earlier letter to NATURE (March 22, 1924) and in a paper presented at a meeting of the American Physical Society (cf. *Phys. Rev.* 23, 554, 1924). It is now found that the equations given in the latter for these bands are incorrect. This is due to a wrong assignment of vibrational quantum numbers, corresponding to what may be described as an insidious violation of the combination principle. With the data first used, this violation was not apparent, but new data disclose systematic, although rather small, deviations. A new and, this time, correct assignment of quantum numbers has now been made. The following equation holds for the position of the null-lines of the Si³⁰N bands (n' = vibrational quantum number of the initial, n'' that of the final state of the molecule).

$$\nu = 2423.4 + 2 + 1016.30n' - 17.77n'' + 0.41n'^2 - 0.0049n'^4 - 1145.00n''^2 + 6.570n''^4.$$

The null-lines, it should be stated, can for many of the bands be measured directly on the plates. At the low temperature of the active nitrogen used in generating the bands, the null-line appears as a conspicuous hole in the band structure, on the low-frequency side of the head.

With the new numbering, the various apparent abnormalities previously noted disappear, and an analogy of the SiN bands to the violet CN bands is brought out. In particular, the isotope effect, previously thought abnormally large for the initial state of the molecule, is now completely normal. Agreement with the theory is exceedingly good if the emitter is assumed to be SiN. No other assumed emitter gives agreement with the experimental data; even for SiO, the agreement is poor. Thus the value of the isotope effect in the identification of the emitters of band spectra, emphasised in a previous letter (April 5, 1924), is again confirmed. As in the case of the BO bands, so in the case of SiN, the testimony of the isotope effect is backed up by the chemical evidence (NATURE, Sept. 6, 1924, and *Phys. Rev.* 25, 259, 1925).

The agreement of the results with theory is much better if the integral vibrational quantum numbers 0, 1, 2, . . . are assumed than if the half-integral numbers $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$, . . . are used. In this respect SiN differs from BO, for which the data indicate (cf. refs. last cited) that half-integral values are needed.

A detailed account of the work on the SiN bands is now being prepared for publication.

ROBERT S. MULLIKEN,
National Research Fellow.

Jefferson Physical Laboratory,
Harvard University,
May 16.

Planetary Densities and Gravitational Pressure.

IN astronomical works the densities of the sun and planets are taken as the ratios of the masses to their apparent volume, the masses being determined by the periods of the bodies which revolve round them.

For the sun itself, and for several of the planets (notably for Jupiter and Saturn), the density so determined is much less than that of the earth, and it seems very improbable that this should really be the case, considering that the materials of which they are composed are the same as those which make up the earth, and that the gravitational pressure to which they are subjected is much greater than that which could be produced by terrestrial gravity.

In the case of the sun, Venus, Jupiter, and Saturn, in which the visible part is vapour or cloud, it seems most likely that there is a dense nucleus in which most of the mass is concentrated, and, assuming for the moment that the whole mass is so concentrated, it is a simple and direct problem to determine the size of the nucleus for any given density.

The depth of the non-solid covering will be the difference between the apparent semidiameter and the radius of the nucleus, and if the latter has the density of the earth, the approximate dimensions in miles are as follows:

	Apparent Semidiameter.	Radius of Nucleus.	Thickness of Envelope.
Sun . . .	432,000	278,000	154,000
Venus . . .	3,800	3,600	200
Jupiter . . .	45,000	28,900	16,600
Saturn . . .	37,500	19,000	18,500

If the density depends on the gravitational pressure, the diameter of the nucleus will be less than the above for the sun, Jupiter, and Saturn, and rather greater for Venus.

There are no experiments on the variation of density of solids under large pressures. If a rod of the mean density of the earth is supposed to reach from the surface to the centre, the pressure on its base is just half that which the same mass would exert at the surface when resting on the same area. Taking the earth's radius as 21 million feet and the earth's density as 5.6, this gives 11,400 tons per square inch as the pressure at the earth's centre.

I have seen no mention of trustworthy experiments at even 100 tons per square inch, and in my own work have never gone beyond 30 tons.

In some trials with precipitated chalk, using pressures of 25 tons to the inch, I have obtained blocks with a density of 1.6 to 1.7—much the same as the density of the upper chalk. In the lower chalk, however, the density sometimes exceeds 2, and it would be interesting to know whether this is the result of gravitational pressure.

A. MALLOCK.

Spiral Springs of Quartz.

I AM greatly interested in the account in NATURE of June 20, p. 943, of the manufacture of spiral springs of fused quartz by Dr. Shupas, and the comment by Prof. Boys on the achievement.

During the last eighteen months we have been employing similar springs of fused quartz in this laboratory in the measurement of sorption, a preliminary announcement of their use appearing in the Journal of the Am. Chem. Soc. for December of last year (Baker and McBain, p. 2722), and a full account of the sorption balance is now being communicated.

Our experiences confirm in every way the observations made by Dr. Shupas in his letter. Several members of the laboratory have prepared these springs of varying dimensions, using the ordinary coal-gas-air blow-flame for forming the coil. (The oxygen-gas flame was, of course, employed for the drawing-out of the fibres from the thick rods of quartz.) The quartz fibre is attached by a smear of sealing-wax to an ordinary arc-lamp carbon of suitable dimensions, which is supported in a well-bored cork, so that it may be rotated about its longitudinal axis. A small weight is suspended from the free end of the fibre, which is then coiled by slowly turning the carbon rod, the fibre being heated by the blow-flame at the point

at which it is being bent. As mentioned in Prof. Boys's note, the close or open coiling of the spring may be effected by slight inclination of the rod to the horizontal, and evenness in the winding is readily secured. When the coil is completed, it is removed from the rod by gentle tapping, and the hooked ends bent into the axis of the coil. We have observed no deterioration of the quartz due to the contact with the hot carbon rod, or to the use of coal-gas.

Spirals of fused quartz fibres of from 0.1 to 0.2 mm. diameter, having from 15 to 30 coils of diameter 0.5 to 1.5 cm., have been prepared in considerable number. Some large springs with coils of 2 cm. diameter were made to order by Messrs. The Silica Syndicate, and these had the same average extension per unit weight suspended from them as the spring of the same dimensions instanced by Dr. Shupas. Considerably more sensitive springs have been manufactured, but they were too delicate for the purpose for which they were required. There appears to be small limit to the sensitivity that can be obtained, provided that the maximum load required to be carried be small. As an example of a typical spring which we are employing—of the less sensitive kind—we can get a spring that will carry a total load of approximately 0.8 gram, giving an extension of 0.9 cm. per 0.1 gram load; diameter of coils, 1.3 cm.

In the manufacture of long springs we have found it quite easy to join two or more fibres together, using the oxygen flame.

H. GREVILLE SMITH.

The University, Bristol,
June 22.

The Quantum Analysis of New Nitrogen Bands in the Ultra-Violet.

In a previous letter (NATURE, 114, 642, November 1, 1924), one of the writers predicted a new group of nitrogen bands with an origin at about 65,000, having for its initial state the final state of the first positive group, and for its final state the stable condition of the neutral molecule. A group of strong bands in almost precisely the predicted position has now been measured and analysed, but, contrary to expectations, the progressions of this group are not related to those of any other analysed group of nitrogen, or of any other substance.

The new group was obtained with purified nitrogen, at 0.003 mm. pressure, in a long tube, with flowing gas, using ordinary arc discharge. The spectrograms contain the usual nitrogen groups and in addition thirty bands, degraded to the red, extending from $\lambda 1354$ to $\lambda 1854$. Seventeen of the thirty have previously been observed by Lyman ("Spectroscopy of the Extreme Ultra-Violet," pp. 82 and 113). The distribution of intensity, except in minor particulars, is similar to that of the second positive group (a typical case), and hence indicates very definitely the correct assignment of vibrational quantum numbers. The resulting equation for the new group is

$$\nu = 68,956.6 + (1681.45n' - 15.25n'^2) - (2345.16n'' - 14.445n''^2),$$

where n'' varies from 0 to 9, and n' from 0 to 3 only, the average (Obs.—Calc.) being 0.1 Å.

There are many other bands (or at least hazy lines) between $\lambda 950$ and $\lambda 1350$, some of which are quite strong, and also a few rather weak bands between $\lambda 1350$ and $\lambda 2100$, but as yet no consistent numerical relations are apparent.

R. T. BIRGE.

J. J. HOPFIELD.

University of California,
May 11.

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Sir William Fletcher Barrett, F.R.S.

IN Sir Oliver Lodge's notice in NATURE, June 6, p. 880, of the late Sir William Barrett he says that he (Sir William) "claimed" to have discovered some alloys of iron. Reference to published scientific papers would have shown Sir Oliver that Sir William read a paper in 1899, published in the Transactions of the Royal Dublin Society in January 1900, on the magnetic and electric properties of the alloy now known as stalloy, which is indispensable in the construction of transformers, dynamos, etc. Indeed he was told by an authority that this discovery had saved six million pounds in the construction of the Panama Canal alone. Another alloy, permalloy, is likely to be of even greater use in the future.

That Sir William did not do much more for original research was due to his extreme conscientiousness, in considering that, holding the chair of physics, his first duty was to his pupils, and no private work was ever allowed to interfere with that.

Sir Oliver further says that Sir William had "a stimulating hand in founding the Society for Psychical Research." It was entirely due to Sir William's initiative that the society ever came into being, in order to examine obscure psychical phenomena critically and scientifically. In this work he encountered much ridicule and hostile criticism, but he never suffered this or the undoubted obstacle thus created to his material advancement to hinder him in his arduous and devoted search for truth.

ROSA M. BARRETT.

I WELCOME Miss Barrett's supplementary letter about her brother's work. It is unsafe for a writer of an obituary notice to usurp the functions of a law-court to decide questions of priority or completeness of invention. "Stalloy" was, I believe, a subject of controversy, but those who knew Barrett well may hold that any claim made by him must have been well founded. As to the initiation of the S.P.R., Miss Barrett will find a notice in a forthcoming number of the Proceedings of that Society, wherein full credit is given him, with first-hand knowledge, by Mrs. Henry Sidgwick.

OLIVER LODGE.

A Geological Lecture Illustration.

THE following illustration, which occurred to me while preparing one of a series of talks to schools for the British Broadcasting Company, may be of interest to those who are concerned in teaching elementary geology, though it may not be new.

Almost every one has seen the heaps of sample carpets in large furniture stores. Let the carpets represent the successive strata as laid down in past time. Now suppose that a thick board or wedge be driven underneath the pile of carpets: this will produce a humping up of all the carpets just above the wedge. If we then suppose that the humped-up portion is subjected to continuous wear (denudation) it is quite conceivable that the upper carpets will be worn right through and the lower carpets (older strata) become exposed. The frayed edges of the worn-away carpets become the escarpments of the upper strata; and the analogy may be easily extended by considering carpets of different textures. Other types of deformation may of course be given to the pile, and the geological map subsequent on denudation easily deduced.

G. N. PINGRIFF.

Merchant Taylors' School,
E.C.1.

Problems of the Rhone Delta.

By R. D. OLDHAM, F.R.S.

I.

IT has long been known that the delta of the Rhone has undergone great changes since the close of the period of Roman empire. The changes are attested by historical records, but the evidence is contradictory; in part it seems to indicate a rapid advance of the sea face of the delta during the Middle Ages, yet there are mentions of places and dry land almost up to the present limit, and there is clear proof that places close to the existing coast-line were dry land and inhabited during the Roman period. These contradictions gave rise to a large volume of discussion, at times very controversial, by archæologists, geographers, and geologists during the last century, but the result was inconclusive, for the key to the solution had not been found. Work done

river are bordered by fully developed alluvial plains, while between them is a tract of marshy or flooded country, not yet fully reclaimed from the sea, and as such it has generally been interpreted; some strips of ground, too high to be part of the alluvial plain, being regarded as relics of old coastal barriers, now separated from the sea by the advance of the delta.

The description of M. Denizot puts the question in a different light, for he describes the country round the étang de Vaccarès, on the north, the east, and west, as rising to heights of two to three metres, with an undulating surface, the result of subaerial denudation, and in the alluvium forming this high land, he found fossil remains of *Cardium edule*, and other living marine molluscs, at heights of more than a metre above sea-level. As cockles cannot live and thrive above high-water mark, it is evident that, since these deposits were formed below sea-level, there must have been an uplift of the land, and the relation of the present surface to the Roman remains, which are found in this region, shows that this uplift, though extremely recent in the geological sense, must have preceded the advent of the Romans, and probably of their predecessors, the Phœceans and Phœnicians.

Though very recent, this uplift is not the most recent change of level which has taken place. In 1903, Mr. R. T. Gunther established for the neighbourhood of Naples a series of regional changes of level, which ended up by leaving the land some twenty feet lower, relative to the sea, than during the Roman period, and, since then, evidence has accumulated of a similar change

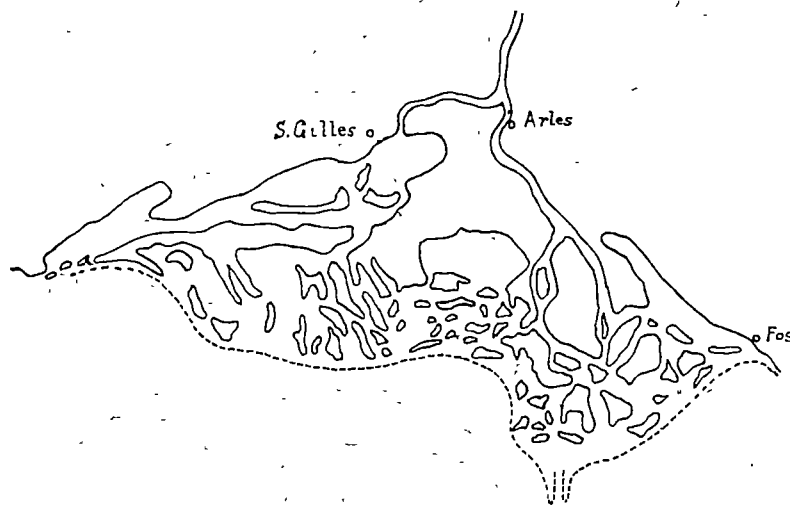


FIG. 1.—The Rhone delta about the end of the tenth century. This sketch does not attempt accuracy of detail; it is purely diagrammatic and intended to represent the general type of topography which resulted from the subsidence in the Dark Ages. The outline of the waterways must have been more intricate than can be restored, or represented, on a small-scale map. The broken line represents, approximately, the outline of the delta in Roman times.

since the beginning of the present century has thrown a new light on the problem, and especially a geological study by M. G. Denizot, which was published in 1924 by the Société Géologique de France, has made a re-examination of the question possible, and led to the possibility of drawing an outline of the changes which have taken place since the dawn of our era.

On a map of the region, the river Rhone is seen to divide just above the city of Arles into two branches, of which the western flows past St. Gilles and, curving to the southwards, enters the Mediterranean just west of the village and shrine of Saintes Maries, while the main stream, which carries four-fifths of the water, flows southwards to the sea, keeping near the eastern margin of the delta proper. Between these two streams is a triangular tract of country, known as the Camargue, and in the middle is an expanse of salt water, the étang de Vaccarès, which communicated freely with the sea by an island-studded stretch of water before it was cut off by the formation of an artificial protective embankment. As seen on a map, the appearance is that of a normal alluvial delta, where the two branches of the

of level in other parts of the Mediterranean, from Venice to Alexandria and Carthage, nor is it wanting along the coast of Provence. In the very region of the Rhone itself, remains of Roman buildings have been found below sea-level, in the étang de Vaccarès; and in the Gulf of Fos are remains of old buildings, regarded as remains of the port of Fossæ Marianæ, which was an important seaport in the early centuries of our era.

A very vivid description of these is given by M. Toulouzan, who mentions buildings, and long jetties of stone, as visible beneath the sea in calm weather. The archæology of this writer was so brightly tinged with imagination, that the existence of these ruins has been doubted, or denied, but there is independent evidence of the remains existing under the sea, in the Golfe de Fos, and the discovery of remains of Roman construction below sea-level has also been recorded in the étang de Vaccarès. Apart from this, M. Denizot, in the paper referred to, gives evidence of subsidence of the land near Fos, though he denies the possibility of its amounting to anything like nine metres. That some

subsidence of the land has taken place is, therefore, established, but the direct evidence on record, if we except the statements of M. Toulouzan, does not give a measure of it. For this we must look to the changes which have taken place in post-Roman times, which not only give indirect corroboration of the subsidence, but enable its amount to be estimated, as certainly not materially greater than five, or less than four, metres, and the date to be fixed as in the period which elapsed between the beginning of the eighth and the close of the tenth centuries.

One result of the recognition of this change of level is that the current conceptions of the delta in Roman times must be revised. The whole region then stood some twelve to fifteen feet higher above sea-level than at present, and, if the land were again to be raised to this level, the whole of the great expanse of water, forming the étang de Vaccarès and extending to the sea, as well as all the salt lakes, which are in more or less direct communication with the sea, or only cut off by alluvial and coastal barriers, would be converted into dry land. The delta, instead of being smaller than at present, might have extended farther out to sea than now; the great spreads of pestiferous salt marshes, which render the country almost uninhabitable, would be largely or entirely drained, and instead of the subsoil being everywhere so charged with salt that a supply of drinking water can only be procured by storing the rainfall, it would probably be obtainable from surface wells. The country, in fact, would be fertile and habitable, justifying the description of the ancient writers, and accounting for the numerous remains of considerable settlements which have been, and are still being, found. Through this region the branches of the Rhone would flow in channels cut out of the up-raised alluvium, with a flood-plain on either side, and the mouths would issue on the sea-face, where the action of the waves, driven directly against the bar by the prevailing storms, would give rise to the same difficulties and dangers of navigation as at present, troubles which Caius Marius solved, in the same way as the French engineers of the last century, by cutting a ship canal from the river to the sea.

With the subsidence in post-Roman times, a change in the conditions took place. In a region where no point rose more than thirty feet above sea-level, the whole of the low lands would be submerged to a greater or less extent; numerous creeks and channels would penetrate the land, converting the gently undulating ground into islands of varying size, separated by channels of varying width and depth; the river, instead of ending on the exposed sea-face of the delta, would debouch into deep and sheltered inlets of the sea; the conditions leading to the formation of a shallow and dangerous bar would be mitigated, and the entry made possible for ships of greater draught and tonnage than before or at present. In the network of channels and expanse of shallow water, resulting from this subsidence, the recovery of land from the sea, by the alluvial deposits of the river, would take place with rapidity, the position of the mouth, and the course of the channel, would be continually changing, until the river once more reached the sea-front of the delta. One region, however, was protected by the accident of configuration of the surface, and while, on either side, the

channels were largely filled up by river silt, the great étang de Vaccarès, with the island-studded waters to the south, remained little affected, and have preserved a representation of the conditions which must have been widespread, along the whole of the outer portion of the delta.

Besides the numerous salt lagoons, or étangs, which owe their origin to this subsidence, there are expanses of modern alluvium, which, but for the complete embankment of the river, would still be in process of formation. This modern alluvium, according to M. Denizot, can often be sharply distinguished from the older, prehistoric alluvium, on the undulating, eroded surface of which the Roman settlements were built; in other places the boundary is less easily recognised, but the distinction is none the less complete, and it is largely possible, by an examination of modern maps and a comparison with older ones, to extend his direct observations, and to compile a map which will, at least, give an indication of the general distribution of land and water at the time when the subsidence had ceased, and before sedimentation had been able to make material progress.

Such are the deductions which may be drawn from a purely geological study of the region. It remains to be seen how far they are consistent with, or supported by, historical records.

II.

The western branch of the Rhone, which takes off from the main stream just above Arles, flows past St. Gilles and then bends southwards to enter the sea by the Grau d'Orgon, near Saintes Maries, but the last part of the present channel, from Silvéral on, dates only from 1552, when the river broke away from its old course. Before that date it had followed another channel, farther west, now known as the *Rhône mort*, past Peccais, to the salt lagoons south-east of Aigues-mortes, and in 1532 was diverted from them by a cut direct to the sea, which became known as the *Rhône vif*, the mouth of this channel becoming the *grau neuf*. Between St. Gilles and Silvéral the river crosses a great expanse of marsh and swamp, which extends westwards towards the étang de Mauguio, and is separated by a barrier of slightly higher land, an inland delta of the Vistre and Vidourle. M. Denizot refers to this tract, which he recognised as composed of modern, or as we may say, post-Roman alluvium, quite distinct from, and newer than, the older alluvium forming the more elevated undulating surface to the south of it. Even now the greater part of this ground can scarcely be described as dry land; it is mostly swamp and, in all but the most recent maps, considerable tracts are shown as permanently flooded. It bears all the appearance of being a tract which has been reclaimed by river deposits in quite recent times. A relic of this old, and once extensive, sheet of water, which spread over this ground, may be seen in the étang de Scamandre, still about six feet in depth, and evidently bounded by the sloping surface of the alluvial plains of the Rhone on the east and the Vistre on the west.

It is not possible, from the information available of a geological or topographical character, to determine whether this sheet of water formerly extended westwards to the étang de Mauguio; for this we must look

to historical records, and foremost among them may be put the history of St. Gilles. By some writers this place has been identified with the Heraclea, mentioned by Pliny the younger, on the strength of a supposed inscription, which has been wholly discredited by later research. That a Roman town stood where it now stands is certain, but this was not Heraclea, for Pliny mentions that place as one which had become legendary, even in his time, and there is not only no evidence, but a strong presumption, that the St. Gilles of Roman times was not in use as a port. It was otherwise in the eleventh and twelfth centuries, when the Dark Ages were passing away, for at that time St. Gilles was not only a recognised seaport, but also the most important one along this coast. In 1109 Raymond of St. Gilles collected there a fleet of forty ships, to transport an army of four thousand fighting men to the Crusades. Three years later the Knights Hospitaller of St. John founded their first establishment outside the Holy Land at St. Gilles, because it was then the port most used by pilgrims to and from Jerusalem. Mention of the use of St. Gilles is fairly frequent in the records of the twelfth century, and in 1160 the Rabbi Benjamin of Tudela describes it as a flourishing town frequented by visitors from the most distant lands, situated on the banks of the Rhone, and within three miles of the sea. As the sea is now nowhere within five times that distance of St. Gilles, and as there is a continuous strip of what must have been dry land, though possibly penetrated by channels, the sea of the Rabbi could not have been the Mediterranean; it could only have been that expanse of water which has been referred to.

These accounts give no clue as to the direction in which the navigable channel of access lay, but an incident of the wars between the republics of Genoa and Pisa throws light on this subject. Some Pisan galleys, pursued by Genoese, took refuge by ascending the Rhone to St. Gilles; the Genoese, instead of following them, went up the main stream, past Arles and, rounding the point of the Camargue, descended the lesser branch of the river to St. Gilles. The Pisans hearing of their approach fled down stream, as the chronicle reports, by another river and another mouth called the Gradus Capræ, which appears in the French version as Grau de la Chèvre, where the Genoese, in pursuit, captured and burnt some of the galleys and proceeded, searching for more, until they reached the Grau de Montpellier, now called Palavas, where they met a contrary wind and had to return by the river to Arles and so on to Genoa.

This is the last appearance in history of St. Gilles as a port accessible from the sea. In the following century, when Aiguesmortes was founded, in 1240, St. Gilles could no longer have been a seaport; it is certain that there was no direct access to it from the étang de Mauguio, and the Grau de la Chèvre of the thirteenth and fourteenth centuries was the mouth of the old river course, of the *Rhône mort*. This channel, however, seems not to have been navigable, and it is very questionable whether it was meant, in the record of the naval adventure of 1165; if the statement of the Rabbi Benjamin of Tudela can be accepted, the river had not then extended so far, and the narrator, without definitely stating it, implies that the course from the Grau de la Chèvre to Montpellier was in sheltered waters, and not

in the open sea. The implication is that the access to St. Gilles was from the westwards, and if so its decline and disappearance, as a port of destination, was due to the closing of this channel on one hand, and the advance of the western and smaller branch of the Rhone on the other.

This conclusion is strongly supported by a study of those remarkable relics of the Middle Ages known as the portolan maps. It is known, from incidental references, that sea-charts of some kind were in use in the twelfth century, but they appear to have been mere sketches, drawn from memory by navigators, of the approaches to individual ports, or of stretches of coast-line; only towards the end of the thirteenth century did the normal portolan appear. This gave a representation of the Mediterranean and Black Seas, and of parts of the Atlantic coasts of Europe and Africa, with a surprising degree of accuracy. The origin and history of these maps have been the subject of much discussion, but it is generally agreed that they were sea-charts made for the use of sailors, that they originated independently of, and were uninfluenced by, any earlier maps, and that, once the type had developed, they went on being reproduced, with merely variations in detail, throughout the succeeding centuries until the seventeenth or even into the eighteenth century.

In the region of the Rhone Delta, the maps all represent a broad inlet of the sea, stretching from Cette to the Rhone, drawn in a conventionalised outline and dotted over to represent shoal water. To this statement an exception must be made of a few of the earliest maps; in the very earliest, the Carte Pisane of the end of the thirteenth century, the representation of the mouth of the Rhone is so purely conventional that no conclusion can be drawn from it; of slightly later date, 1318, are two maps by Petrus Vêrconte, of very different character and great interest. They represent a great inlet of shallow water, extending from just east of Cette, over the étang de Mauguio to beyond where St. Gilles would be, were it marked on the map; and, more than that, one of these maps also shows a sheet of water, north-eastwards of the termination of this inlet, in the position of the tract of land, between St. Gilles and Beaucaire, which was permanently flooded until it was drained by the digging of the canal from Beaucaire to Aiguesmortes. In neither of these maps does the inlet extend to the Rhone, but stops short, and at the eastern end a river is shown entering it, which must be meant for the western branch of the Rhone.

It is impossible to examine these maps without being struck with the facts, that they evidently owe nothing to any pre-existing map of which we have any knowledge, and that they are equally evidently an attempt to represent something which really existed. The author of the general map must have had before him a local chart of this region, probably one of those mentioned above, which had been drawn at a time when St. Gilles was still a port; but this was a century before



Fig. 2.—Coast-line between Cette and Cap Couronne, from the Catalan Atlas of 1375. This shows the general type of the representation of the Rhone Delta, which runs, with small variations, through the whole series of the portolan maps, with the exception of the early one by Petrus Vêrconte, shown in Fig. 3.

the map was drawn, and so the omission of the name of St. Gilles can be accounted for. Vesconte knew that there was no longer a port of St. Gilles, if he knew that there ever had been, and, being of no interest to those for whom the map was made, it was omitted, but the topography he took, directly or indirectly, from the older map. If this map is compared with a restoration of the twelfth century topography, as deduced from



FIG. 3 — Coast between Cette and Cap Couronne, from the map by Petrus Vesconte, dated 1318.

modern maps of the region, the agreement, as regards the eastern end of the inlet, is so close, that his representation of the western portion, where direct restoration is more uncertain, may be taken as corroboration of the western approach to the port of St. Gilles.

The later history of these maps, so far as it affects this region, may be briefly summed up. The Vesconte map is the last which gives an air of reality to the western channel, and it is probable that in contemporary maps, by other makers, the representation had already assumed the conventional form, seen in the Dulcert map of 1339, and repeated throughout the series of later maps. At the same time, there is a great advance in the representation of the sea-face, which maintained a remarkable correctness until about the middle of the fifteenth century; after that, a change of conditions, by deterioration of the channels of access to Arles and Aiguesmortes, and by the increase in size of the merchant ships, led to this coast being avoided by the mariners who used these charts, and a steady deteriora-

tion set in, due to errors introduced by repeated copying, uncontrolled by any check.

From the evidence outlined above we may reconstruct the history of St. Gilles as a seaport. In Roman times it was an inland town, of no great importance, past which one of the branches of the Rhone flowed, as at the present day, but, instead of turning southwards, the river flowed on to the west, in a valley cut out of the upraised alluvium, to where the étang de Mauguio now stands. Then came the subsidence in the Dark Ages, the lower part of this valley became submerged, and an inlet of the sea was formed, with sufficient depth of water to enable ships to reach St. Gilles, which, by 1080, had become so well established that it was selected as the most appropriate landing-place for a princess of Sicily, on her way to the Court of France. The importance and prosperity of the port increased during the succeeding half-century or more, but, once further subsidence of the land had ceased, the alluvial deposits of the river began to advance into the flooded lands until St. Gilles, instead of being a port on an inlet of the sea, became a town on the banks of a small river, and at the same time the rivers Vistre and Vidourle, entering the inlet near its western end, built up a barrier across it. These two causes, combined, made access from the sea to St. Gilles increasingly difficult until, by the end of the twelfth century, its life as a seaport had come to an end. Since then, the remains of this old inlet were gradually filled up by silt deposited from the flood-waters of the rivers, and the process would still be going on, if these rivers had not at last been completely hemmed in by flood-proof embankments.

(To be continued.)

The Centenary of the Railway.

By Engr.-Capt. EDGAR C. SMITH, O.B.E., R.N.

THE celebration of the centenary of the opening of the Stockton and Darlington Railway is an occasion of world-wide interest, for from that pioneer line has sprung the vast network of railways which stretches to the uttermost parts of the earth. It was the first of British public steam railways, and just as the Romans were the great builders of roads, so our race became the great builders of railways. Even as British ships navigate every sea, so railways designed by British engineers traverse every continent. The modern textile industry and the steel industry both had their birth in our isles, but it is probable our three greatest contributions to material progress were the steam-engine, the steam-ship, and the locomotive. Watt and Stephenson, like Shakespeare, Newton, and Faraday, have been eulogised beyond measure, but we are perhaps even now too near the revolutions they set in motion to realise their full significance in the history of mankind.

The Stockton and Darlington Railway was opened on September 27, 1825, when George Stephenson drove his famous engine *Locomotion* from Darlington to Stockton with a train of miscellaneous vehicles and trucks filled with goods and passengers. That great experiment must always be associated with the name of Stephenson, who, however, was but the outstanding representative of the pioneers of the steam railway to whom tribute

should be paid. Tracks of wood and wheels of iron had been in use for many years. In 1801 William Jessop had built the first authorised public line, the Surrey Railway. It was probably Jessop who gave us our gauge of 4 ft. 8½ in. By 1820 railways were becoming common, and no fewer than twenty were sanctioned in that year alone. These were worked by horses. In the eighteenth century, Cugnot, Murdock, and Trevithick had all built steam-carriages; and in 1804 Trevithick set a locomotive to work on an iron track in Wales. In this engine he used the exhaust steam as a blast. Two or three years later Trevithick had one of his engines running round a track where Euston Square now stands. Blenkinsop's engines with cogged wheels date from 1812, and about the same time Foster and Hackworth assisted Hedley to construct *Puffing Billy* and *Wylain Dilly*, the two oldest locomotives now extant. Stephenson's first Killingworth engine *Blucher* was built in 1814, his second in 1815, and eight years later, with assistance from Pease, Richardson, and Longridge, he opened his engine factory at Newcastle, where *Locomotion* was built.

Originally projected by Edward Pease as a mineral line for bringing coals from near Bishop Auckland to the sea, the plans for the Stockton and Darlington Railway were passed in 1821, and two years later, largely through Stephenson, powers were obtained for

carrying passengers and for using locomotives, the general idea being to use locomotives on the level and stationary winding engines for the inclines. At first *Locomotion* was the only locomotive, but it was soon followed by other engines afterwards named *Hope*, *Black Diamond*, *Diligence*, and *Royal George*, for it was found that "an intercourse and trade seemed to grow out of nothing." Stephenson by now was also engineer to the vastly more important railway, the Liverpool and Manchester, and just as he had prevailed upon Edward Pease to use the locomotive for the Durham line, so he converted the proprietors of the Lancashire line to his ideas. When the line was nearing completion a prize of 500*l.* was offered for a locomotive fulfilling certain conditions, and the remarkable success of the *Rocket* at the historic Rainhill trials held in October 1829 sounded the knell of both horse railway and stationary-engine railway. A year later the Liverpool and Manchester Railway was formally opened by a procession of eight locomotives, headed by the *Northumbrian*, driven by Stephenson, and with that event the era of the steam railway set in.

Railway progress since those early days has been due to two great schools of engineers: the mechanical engineers devoted to the design and construction of rolling stock, and the constructional engineers responsible for the track. To the former belong both George and Robert Stephenson, Hackworth, Bury, Crampton, Gooch, Fairlie, Ramsbottom, Baldwin, Webb, Belpaire, Borsig, de Glehn, Mallet, Pitkin, and Vaucrain, whose names have been household words. Between the *Rocket*, weighing with her tender $7\frac{1}{2}$ tons, and the giant *Virginia*, built by the American Locomotive Co., weighing 450 tons, lies the work of a great army. With her fire-box surrounded with water spaces, her copper tubes and her direct drive, the *Rocket*, compared with anything which had gone before, was as a racehorse to a dray horse. It was in the *Planet*, however, that the cylinders were placed under the smoke-box with the driving wheels aft as we have them to-day.

In the history of the locomotive it is impossible to say too much for Howe's invention of the link gear, which gave the driver a simple means of reversing, and also of regulating the cut-off in the cylinder. The link gears of Walschaerts, Gooch, Allan, and Joy were all later than Howe's invention, which was made in 1842. Other landmarks in the history of the locomotive are the brilliant invention of the injector by Giffard, the introduction of his ingenious water trough by Ramsbottom, the use of compounding by Mallet and Webb, and the introduction of superheating, notably by Schmidt. But in truth every part of the engine and boiler, tubes, valves, gauges, cylinders, pistons, springs, bearings, axles, and cranks, have been the subjects of close investigation and continual improvement. In the development of rolling stock, special mention should be made of the invention in 1869 of the Westinghouse brake, while we are also indebted to the United States for the Pullman carriage and the Swift refrigerator car. Scientific research has long been the handmaid of locomotive engineers, and it is worth recalling that August Wohler's epoch-making work on materials began with the study of axles.

Just as Stephenson was the first to build an iron

railway bridge, so he was the first to lay a line across a bog and to drive one through a hill. There can be no denying him the title of "the father of the railway." After the Liverpool and Manchester line came the London to Birmingham, then the Grand Junction continuing this line to Liverpool, and the South Western, South Eastern, and Eastern Counties Railways. With these and other railways at home and abroad are associated the names of Robert Stephenson, Locke, Brunel, Berkley, Errington, Vignoles, Bell, Hawkshaw, and Brassey. On some of the lines were works of great magnitude. Of the early bridges the most remarkable was the Britannia Bridge over the Menai Straits. Its originality, its great length, its height, and the audacity and skill displayed in raising the immense spans to the top of the towers created as much interest in the public mind as the building of the *Great Eastern* in the next decade. Robert Stephenson and Fairbairn were the engineers of the bridge, and for Fairbairn, Hodgkinson carried out his important inquiries on the strength of iron structures. The Britannia Bridge was opened in 1850. Five years later a railway bridge was thrown across Niagara by Roebling, and the year 1859 saw the opening of the Victoria Bridge over the St. Lawrence, of Lohse's bridge across the Rhine at Cologne, and of Brunel's bridge over the Tamar. These bridges, of course, were all built of iron, but with the steel age came even more remarkable structures, such as the Forth Bridge, containing sufficient steel to build two battleships, and the Victoria Bridge over the Zambezi River, high enough to overleap St. Paul's.

Less spectacular than bridge-building, but of equal importance in the development of railways, has been the art of tunnelling. The first railway tunnel was that on the Canterbury and Whitstable line. The elder Brunel's Thames tunnel, begun in 1824, was not a railway tunnel, but it led to the invention of the shield, which, improved by Greathead, has been used for all our tube railways. But the romance of tunnelling centres around the Alps. First came the Mont Cenis Tunnel, then the St. Gothard, then the Arlberg, the Simplon, and the Lötschberg. These have a combined length of 46 miles. It was in the Mont Cenis Tunnel, begun in 1857 and finished in 1871, that Graddon and Sommeiller, through Colladon the physicist, first used compressed air, and it was reading of their work which gave Westinghouse the inspiration for his brake. To the lay mind there is nothing more marvellous than the boring of long tunnels from the opposite sides of a massive mountain range, and making them meet within a few inches. The total discrepancy in the alignment of the Simplon Tunnel, 12 miles long, was only $3\frac{3}{8}$ inches. Tunnelling, like all railway work, may be said, in the words of Emerson, to be "girt about with a zodiac of sciences, the contributions of men who have perished to add their point of light to our sky." If men had not followed the motion of the stars, pored over the mystery of light, or studied fossil forms, the Alps would still have remained as great a barrier to the traveller as they were to the armies of Hannibal, and in commemorating the centenary of the railway we do homage alike to those who have enlarged the boundaries of knowledge and to those who have applied that knowledge to useful ends.

Current Topics and Events.

THE Committee which is to be charged with the responsibility of advising the British Government on Empire problems involving scientific investigation is to be called the Committee of Civil Research. A Treasury Minute issued on June 24 stated that it will be a Standing Committee reporting to the Cabinet, analogous in principle to the Committee of Imperial Defence. "The president of the Committee will be the Prime Minister, and the regular chairman, in the absence of the Prime Minister, will be a minister nominated by him for the purpose, the membership of the Committee will, as in the case of the Committee of Imperial Defence, consist of such persons as are summoned by the Prime Minister, or the chairman on his behalf. The Committee will be an advisory body and will have no administrative or executive functions. It will be charged with the duty of giving connected forethought from a central standpoint to the development of economic, scientific, and statistical research in relation to civil policy and administration, and it will define new areas in which inquiry would be valuable." We must confess that this announcement altogether destroys the high hopes raised by the statement made by Lord Balfour in the House of Lords on May 20. It cannot be too strongly urged that the analogy between the Research and Defence Committee has been carried too far. The expert is in the ascendancy at the Admiralty, the War Office, and the Air Ministry. He has considerable weight given to his opinions, and ministers are not infrequently forced to bow to his judgment on matters of defence. But in matters relating to scientific research in connexion with State departments, this is not the case. The permanent administrative officers in charge of departments are those to whom reference is made, and they determine whose and what advice is to be followed. Until more information is forthcoming regarding the new Committee, we hesitate to pass final judgment upon it. For the moment, however, it appears to us that the administrator has triumphed not only at the expense of the scientific worker, but also at that of the Empire as a whole.

IN the course of his reply in the House of Commons on June 29 to a motion of censure on the Government for its handling of the problem of industrial depression and unemployment in Great Britain, the Prime Minister, Mr. Baldwin, made some noteworthy remarks on the relation of scientific research to industry. "No one," he said, "will assert that British industry can be saved by science alone, but . . . until scientific methods and scientific men can take their place in industry, and an equal place with the administrator and the financier, British trade will never be strong enough or resilient enough . . . to meet the sudden and unexpected changes which will always arise in international trade." Mr. Baldwin thinks that "the present situation in industry will cause our people more and more to turn their minds to what scientific research and scientific management can do." Speaking of expenditure

on research, he stated that "the electrical industry to-day is spending a quarter of a million a year on research—an impressive figure for this country—but there is one company in the United States of America that is now spending 9,000,000 dollars a year and has 3000 trained workers in its research laboratories, and is going to increase that number to 5000, and there is no doubt that victory in the long run will go to the nation which can harness most efficiently and more securely science to its industry." He also referred to Government expenditure through the Department of Scientific and Industrial Research, and to the twenty-four industrial research associations now in being, in order to "show how I regard it as vitally important to link up science with our industries to-day and to say that the Government will always consider in what way they can best help in the attainment of this great object."

THE problem of low temperature carbonisation of coal received special mention in Mr. Baldwin's speech. The present position, according to Mr. Baldwin, is that "research has been going on at the Government station and by various processes in private hands, several of which have reached remarkable results so far as the laboratory is concerned. The time has not come yet when a commercial process has been successfully devised." He stated that he is convinced that "what has been proved successful in the laboratory will be proved successful commercially. . . . If the results of the new experiments at East Greenwich justify it, the Government will certainly consider the question whether they might not erect a plant upon a commercial scale to help in the development of this scheme."

THE third triennial conference of the International Astronomical Union is to be held at Cambridge during the week July 14-22 under the presidency of Prof. W. W. Campbell, formerly director of the Lick Observatory, and now president of the University of California. The meetings will commence with an inaugural ceremony at the Senate House of the University, when it is hoped that the Earl of Balfour, Chancellor of the University, will welcome the conference. The work of the Union is necessarily largely done at the meetings of its many committees, but the General Assembly will meet on four mornings for general business and for the ratification or modification of the reports of the committees. Among visitors from abroad who are expected to be present at the Conference we may mention Prof. Baillaud, M. le Comte de la Baume Pluvinel, Prof. Bigourdan, and General Ferrié from France; Miss Cannon, Prof. E. W. Brown, Prof. S. A. Mitchell, Capt. Pollock, Dr. St. John, Prof. Schlesinger, Prof. Shapley, and Dr. van Maanen from the United States; Prof. Cerulli and Prof. Abetti from Italy; Prof. W. de Sitter, Prof. Hertzsprung, Prof. Nijland, Prof. van Rhijn, and Prof. Zeeman from Holland; Prof. Chant, Dr. Henroteau, Prof. J. C. McLennan and Dr. J. S.

Plaskett from Canada, with Dr. H. Spencer Jones and Senator A. W. Roberts from South Africa; Dr. Comas Sola and Prof. Herrero from Spain; Prof. Nagaoka from Japan; Prof. Zeipel and Dr. Lundmark from Sweden; Prof. Stroobant from Belgium; Prof. Voûte from Java, and Prof. Wolfer from Switzerland. The tale is far from complete, but it is clear that Prof. Fowler, the secretary of the Union, may look forward confidently to a successful gathering and to much useful work being done.

WE have received from Prof. E. H. L. Schwarz, of Rhodes University College, Grahamstown, a letter claiming the recent age of the Taungs skull, on the ground that the change in geographical conditions at the locality may be of modern date, in accordance with his view that the climate of South Africa has undergone a great desiccation in the course of the past century. He therefore considers that forests suitable for great apes may have survived near Taungs until recently. Prof. Schwarz adds: "The Taungs skull was associated with a large number of brain casts of young baboons. Mr. F. Y. FitzSimons informs me that the cave-dwellers of the Zitzikamma used to eat young baboons; the rock shelters are full of bones, but the skulls are all intact, showing that the men did not fancy eating the brains. It is probable, therefore, that the young *Australopithecus*, whose remains have been preserved to us, had been caught as prey by a man of the period. What nature of a man was he? When the bone breccia of Broken Hill, Rhodesia, was first discovered, some very distinctive stone implements were found in it; it was only long afterwards that the skull of Rhodesian man was found in the same deposit. The artefacts are made of clear vein quartz, and are of quite a different type from all other South African ones. I had previously obtained them from the Great Brak River, Mossel Bay, while we have almost identical ones in the Albany Museum, from the Bezuidenhouts River, Johannesburg. The Rhodesian race was, therefore, widely distributed throughout South Africa, so the man who snared the young *Australopithecus* probably belonged to it."

A SCHEME for a very large transmission network for electric power in the eastern part of the United States will probably come into operation in the immediate future. It will link together Washington, Baltimore, Philadelphia, New York and Boston with two of the principal coal-fields in America and with a hydro-electric station obtaining power from the St. Lawrence Rapids. Many small water power plants in the mountains of New York State will also be linked with the network. As the St. Lawrence Rapids are about 300 miles away from the centre of distribution, it is proposed to use the very high pressure of 300,000 volts. As 220,000 volts are already used in California, the American engineers do not anticipate any difficulty. To diminish the inductance of the transmission lines and to prevent brush discharges, several aluminium conductors in parallel will be used instead of one copper conductor. The very large steam plants in New York, Phil-

adelphia, and Boston, all of which obtain their coal by water transport, will supplement the steam power plants in the mine fields and the hydro-electric plants. Luckily abundant feed water is obtainable near the mine fields. The hydro-electric plants will run at full load continuously, the steam plants only being used when the demand exceeds the capacity of all the hydro-electric plants. All manner of labour-saving devices and apparatus for increasing the efficiency can be employed in very large power stations. It is estimated that when this scheme is put into operation, it will save millions of tons of coal per annum, as well as greatly increase the total power available.

ON June 25 the Johnston-Lavis Geophysical Collection, bequeathed to University College, London, under the will of the late Dr. Henry Johnston-Lavis, formerly professor of vulcanology in the University of Naples, was formally thrown open to the public by Sir Henry Miers. The collection contains a complete and unique series of specimens, maps, books, lantern- and microscope-slides illustrative of South American vulcanology since historic times, as well as collections of rocks and minerals from other parts of the world. The collection of Vesuvian minerals, in particular, is probably the finest in the world, and contains most of the species listed by Zambonini in his "*Mineralogia Vesuviana*." Of particular importance are the large number of specimens of the rare minerals apthitalite, nocerite, and chlormanganokalite, the latter mineral being discovered by Dr. Johnston-Lavis himself in the eruption of 1906, and afterwards described by him and L. J. Spencer. The crystals of apthitalite and idocrase described by France are also in the collection. There is, in addition to the Vesuvian and other minerals, a small but very fine collection of ores from the lead-zinc mines of Laurium, Greece, the smithsonites, aragonites, and aurichalcites deserving special mention. There is a large hanging geological map of Vesuvius, prepared by Dr. Johnston-Lavis, showing the distribution of all the lavas since historic times; and a large collection of gashes, coloured prints, engravings, etc., of past eruptions, and a unique library of vulcanological literature dating from 1508. The collection, which is temporarily housed on the two upper floors at 134 Gower Street, is available to the public for purposes of inspection or research on application to the office at University College, Gower Street, London, W.C.1.

THE American Ambassador, Mr. Alanson B. Houghton, unveiled a tablet in the library of the Royal Aeronautical Society on June 29 to the memory of the British and Americans who lost their lives in the wreck of the R. 38 on August 24, 1921. It will be recalled that the airship was built originally for the British Navy, but, on the decision being taken to abandon experimenting with airships, was sold to the United States. It was undertaking a flight carrying a mixed crew of Royal Air Force and United States Navy men together with some of the scientific staff of the National Physical Laboratory, when it broke its back and came down in the Humber,

only four of the crew being saved. Prof. L. Bairstow, in thanking the American Ambassador for performing the unveiling ceremony, stated that the failure of R 38 was a great misfortune to airship development. In his opinion, the airship would bring many achievements, which at present would be regarded as remarkable, within human range; for example, 24 hours from the limits of civilisation to the North Pole or 100 hours from London to India. He also referred to the development of methods of handling airships, and in conclusion stated that, as representing British scientific aeronautics, he hoped that progress would be based on knowledge—that is, research—as part of the tribute which the nations owed to those who had gone before.

SIR GEORGE A. WILLS, Bart., who with his brother the late Mr. H. H. Wills provided means for the erection of the new University buildings recently opened in Bristol by His Majesty the King, has promised a sum of 75,000*l.* for the extension of the Museum and Art Gallery buildings erected in 1904 by his cousin the late Lord Winterstoke. By this gift the exhibition space of the Museum and Art Gallery will be more than doubled, and a much needed opportunity provided of relieving the congestion in all departments which has become very marked during the last few years. The new buildings will be a backward extension of the present Art Gallery and Museum buildings and adjoining the new building of the University, with which they will be in communication. The site area is about 1860 square yards and will allow of the provision of store buildings and staff rooms. It is hoped the work will be completed in two years.

FURTHER details of his Arctic flight are given by Capt. R. Amundsen in his full story published in the *Times* on June 23. The position where he descended in order to take observations, and from which he afterwards returned, is now given as lat. 87° 43' 2" N., long. 10° 19' 5" W. While searching for a landing-place among the floes, Capt. Amundsen had been a little farther north. The two machines descended at some little distance apart. One was abandoned, the crew falling back with some difficulty on the other aeroplane, which was freed from the grip of the ice after long efforts. The chief difficulty then to be faced was the provision of a level run for starting. The rapid drift and continual screwing of the pack for a time destroyed all attempts. At length a track 1800 feet long and 36 feet wide was completed, and by reducing the load to 4180 lb. the explorers contrived to get a start. Then all went well until in close proximity to Spitsbergen they were forced to make a brief halt on the surface of a rough sea before reaching North Cape safely. Capt. Amundsen's full account of his journey reveals no scientific results of importance, and none was anticipated.

ON Friday, June 26, a meeting was held at Dorchester House, Park Lane, by the kind invitation of Sir George and Lady Holford, when Dr. G. Claridge Druce was presented with a book plate, the gift of 250 friends and members of the Botanical and

Exchange Club. The presentation was made by Viscount Grey of Fallodon, who referred in his brief address to Dr. Druce's great botanical knowledge, and dwelt on the kindness which he has shown in putting that knowledge freely at the disposal of others, and his power of inspiring interest while imparting it. Dr. Druce replied, and expressed his thanks for the gift, and his pleasure that it should have been given by Lord Grey, whose love of Nature is so well known. He spoke of the work of the Botanical and Exchange Club, and referred also to the discoveries which have been made by the members in recent years and to the measures which are being taken to prevent the extermination of rare British plants. Dr. Scott then moved a vote of thanks to Sir George and Lady Holford for allowing the meeting to be held in their beautiful house. About eighty of the subscribers were present at the meeting.

It was interesting to note at the close of the War that the Constantinople Museum, thanks in great measure to its Director, Halil Bey, showed less sign of disintegration than many other departments of public life. Nor was it long before its archaeological activities were resumed, and useful work, if not on a very extended scale, was done. The Constantinople correspondent of the *Times* in the issue of June 25 describes excavations now being carried on by the authorities at Kadiköy—the ancient Chalcedon. The foundations of a building about 90 feet long and built of big blocks, many roughly cut, have been brought to light. A fragment of stone containing a cross and surrounded by moulding suggests that the building probably was Christian, and may have been the famous church of St. Euphemia in which the Great Council was held in the year 451. Other signs of an active interest in archaeology among the Turks are to be noted, especially the excavation of tumuli in Angora, the institution of a new branch of the Museum for Assyrian and Hittite monuments, and a new museum for objects of Turkish culture, as well as the projected formation of an ethnographical museum under Halil Bey and Jelal Essad.

SIR RONALD ROSS will open the new building of the British Mosquito Control Institute at Hayling Island, Hants, on Monday, August 31, when a party of members of the Section of Zoology of the British Association, which will then be in session at Southampton, will visit the Institute. The building has been designed to carry on work relating to the study and control of British mosquitoes, which was begun at Hayling Island in 1920 by Mr. J. F. Marshall and a local committee, and has resulted practically in ridding the Island of what was once an intolerable nuisance. The chief offender was found to be the salt-water mosquito *Ochlerotatus detritus*, which breeds in intertidal areas and is common at many seaside watering-places. Before any anti-mosquito measures can be carried out successfully, it is necessary to identify the chief species prevailing in a district, and as the work at Hayling has become known numerous specimens have been sent there for identification and for advice as to the best methods of dealing

with them. It seemed desirable, therefore, to provide a special building to deal with what has grown from a local to a national organisation, and this building, which will contain a demonstration museum, laboratory, drawing-office, photographic room, and other facilities for instruction and research on British mosquitoes and anti-mosquito measures, will shortly be completed. Among the distinguished entomologists and other naturalists who have consented to serve as members of the Council of the Institute are Major E. E. Austen, Dr Andrew Balfour, Sir James Crichton-Browne, Col. S. P. James, Prof. H. Maxwell-Lefroy, Dr. G. A. K. Marshall, Prof. E. B. Poulton, Sir Arthur Shipley, and Sir William Simpson.

IN pursuance of the policy already announced, by which the functions of scientific research and technical development, which were formerly combined in one directorate, have been divided between two directorates, both under the supervision of the Air Member for Supply and Research, Sir Samuel Hoare, Secretary of State for Air, has appointed Mr. H. E. Wimperis to be Director of Scientific Research, and Mr. D. R. Pye to be Deputy-Director of Scientific Research under the Air Ministry. Mr Wimperis has been acting provisionally for some time as Director of Scientific Research. He received his engineering training at the Imperial College of Science, London, and at Cambridge. After several years with important engineering organisations he joined the engineering staff of the Crown Agents for the Colonies, and on the outbreak of war began his intimate association with aeronautics, undertaking experimental work both for the Royal Naval Air Service and the Royal Flying Corps, particularly with regard to navigational and armament devices. He became, on its inception in 1915, head of the Royal Naval Air Service, now the Air Ministry, Laboratory at the Imperial College of Science and has held that position continuously since. He is the author of several works dealing with the internal combustion engine and air navigation and of a number of scientific and technical papers. Mr. Pye is a fellow of Trinity College, Cambridge, and is at present lecturer in engineering at the College. He was trained at Cambridge, afterwards becoming chief assistant to Prof. Jenkin, who was in charge of engineering studies at the University of Oxford. During the War he joined the Royal Flying Corps, and was posted for duty as an experimental officer; later he served at the Air Ministry, acting as scientific assistant to Colonel H. T. Tizard, Deputy-Controller of the Technical Department. Since then he has been working at Cambridge, and has carried out research work in relation to aero engines.

A SEVERE earthquake is reported to have occurred on June 27 on the coast of California. Santa Barbara seems to have been most affected, and according to an account by the New York correspondent of the *Times*, the main street has been broken up and many of the buildings of the city destroyed. The High School, the County Hospital and the Arlington Hotel are referred to in particular as badly damaged. A seismic wave is stated to have flooded low-lying

land along the coast. Twelve deaths have been reported. Shocks were also felt in Butte, Anaconda, Great Falls and Billings.

IN connexion with the 250th anniversary of the founding of the Royal Observatory, Greenwich, and to meet the delegates to the International Astronomical Union, the Royal Society is holding a conversazione on Thursday, July 23, at 9 o'clock.

PROF. BOHUSLAV BRAUNER, Director of the Chemical Institute of the Charles University of Prague, has been elected an honorary member of the Russian Physico-Chemical Society, Leningrad.

COMMEMORATION DAY at Livingstone College, Leyton, was held on June 10. There was a good gathering of old students and others under the chairmanship of Dr Andrew Balfour, who delivered an address. Dr Tom Jays, the Principal, reviewed the work of the College during the past year and appealed for further funds, 800*l.* being needed to close the financial year without deficit.

A PARTY will leave London on July 31 for a holiday, lasting fifteen days, and for field work in geography, geology, botany, and regional survey in the Vale of Chamonix and on the slopes of Mont Blanc. This area is classic ground. The members of the party will go over some of the ground covered by the pioneer workers H. B. de Saussure, Forbes, Tyndall, Vallot, and Ruskin, and attempt to continue their investigations. Particulars of the arrangements may be obtained by sending a stamped, addressed envelope to Mr. Valentine Davis, Cheshire Training College, Crewe.

MR. P. MORLEY HORDER has been appointed architect for the permanent buildings of the London School of Hygiene and Tropical Medicine to be erected on the site adjoining Keppel Street, Gower Street and Malet Street, near the British Museum. It will be remembered that the funds for the erection of the new building are being provided by the Trustees of the Rockefeller Foundation, who offered the British Government the munificent gift of nearly half a million sterling for site, building and equipment.

THE Jerusalem correspondent of the *Times* states in a dispatch which appears in the issue of June 19 that Mr. Turville Petre, in the course of excavations by students of the British School of Archaeology, has discovered the front part of a human skull of Neanderthal type in a cave near Tabzha, to the north of Tiberias. It is said to show the marked characteristics of the type in the highly developed supra-orbital ridges, the receding forehead, and the thickness of the bone. The cave in which it was found is below well-defined historical levels and contains, under a layer of fallen roof stones, a six feet couch of soil rich in Mousterian implements.

WRITING from Finsbury Technical College, London, E.C.2, Mr. H. M. Atkinson informs us that while cycling on June 21 from Norwich to Cambridge, he counted more than sixty dead birds on the road, including wrens, starlings, sparrows, finches and a

(?) hawk, together with several small rodents. Mr. Atkinson noted that birds rose and flew across the road at his approach but were able easily to avoid the bicycle. Apparently they are not so successful in avoiding motor-cars. Mr. Atkinson suggests that head-lights at night, or the polished, tarred road-surface itself during the day time, may have proved the attraction bringing the animals to the road, where they readily fall victims to fast traffic.

THE course of lectures delivered by Mr. W. A. F. Balfour-Browne to a juvenile audience at the Royal Institution last Christmas is to be published by the Cambridge University Press under the title of "Concerning the Habits of Insects." The same house will also issue Sir J. J. Thomson's Fison Memorial Lecture on "The Structure of Light." It is expected to be ready in July.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in the department of civil engineering, architecture, and building in the Bradford Technical College—The Principal (July 8). An assistant pathologist to the Jessop Hospital for Women and the Children's Hospital, Sheffield, and demonstrator of pathology in Sheffield University—The Registrar of the University (July 11). A senior research assistant at the Building Research Station of the Department of Scientific and Industrial Research—The Secretary, 16 Old Queen Street, S.W.1 (July 20). Two probationer naturalists (one with special qualifications in mathematics and a knowledge of biometry and statistics, and one with

natural history qualifications, preferably with subsidiary physiology) under the Fishery Board for Scotland—The Fishery Board for Scotland, Edinburgh (July 31). Temporary assistant chemists in the Government Laboratory—The Government Chemist, Clement's Inn Passage, W.C.2 (July 31). The professorship of anatomy in University College, Dundee—The Secretary and Registrar, University, St. Andrews (August 1). The William Prescott chair of the care of animals—causation and prevention of disease—in the University of Liverpool—The Registrar (September 15). A lecturer on tropical hygiene at the London School of Hygiene and Tropical Medicine—The Secretary, 23 Endsleigh Gardens, N.W.1. Head of the commerce department of the Portsmouth Municipal College—The Secretary, Offices for Higher Education, Municipal College, Portsmouth. A physical laboratory steward at the Woolwich Polytechnic—The Principal. A woman teacher of physiology at the Chelsea Polytechnic—The Secretary, Chelsea Polytechnic, S.W.3. A technical assistant at the Royal Aircraft Establishment, South Farnborough, Hants, for work in connexion with photography, with special application to aerial photography—The Superintendent (quoting A. 76). A junior technical assistant at the Royal Aircraft Establishment, South Farnborough, Hants, for experimental work in aerodynamics—The Superintendent (quoting A. 75). A junior technical assistant at the Royal Aircraft Establishment, South Farnborough, Hants, for general physical work in connexion with instruments—The Superintendent (quoting A. 66).

Our Astronomical Column.

NOVA PICTORIS.—A letter from Mr H. E. Wood, of Johannesburg, contains the interesting announcement that the Nova has been identified with a star of magnitude 11.0, on the C.P.D. photographic scale, which appears on photographs taken with the Franklin-Adams Star Camera on March 17, 1914, March 18, 1914, February 10, 1921.

Its brightness before the outburst is slightly less than that of Nova Aquilæ 1918, and considerably less than that of T Coronæ.

The position for 1925.0 is R.A. 6^h 34^m 57^s.2, S. Decl. 62° 34' 33"; annual precession +0^s.528, S. 3^s.02. Dr. H. Spencer Jones stated at the meeting of the British Astronomical Association on June 24, that the Cape photographs of the spectrum indicated the usual bright bands, but they showed less shift than was the case with most Novæ. The bands were less conspicuous 10 days after discovery, although the magnitude had risen from 2.4 to 2.0.

COMETS.—Several observations of Tempel's comet have been obtained. Its magnitude is about 11; as it approaches both earth and sun during July it will steadily brighten, but this is offset by its southward motion.

The following ephemeris for 0^h is by M. Ebell (B.Z. 24):

	R.A.	S. Decl.	log <i>r</i> .	log Δ.
July 1.	18 ^h 30 ^m 47 ^s	4° 58'	0.140	9.578
9.	18 34 46	8 50	0.133	9.545
17.	18 40 27	13 40	0.127	9.522
25.	18 48 32	19 24	0.122	9.509

The comet is due south about 23^h. It is near 2 Aquilæ on July 9. This comet has the third shortest period of any known comet. Encke and Skjellerup (1922 I) come at the head of the list.

Mr. J. Larink has deduced a new orbit of Schorr's Comet (1918 III).

T = 1918 Sept 28.603 G.M.T.

$\omega = 278^{\circ} 38' 47''$

$\Omega = 118^{\circ} 0' 33''$

$i = 5^{\circ} 35' 2''$

$\phi = 28^{\circ} 5' 1''$

Period, 6.7071 years.

Mr. Larink finds 1925 May 27.90 G.M.T. (new) for the recent perihelion and gives the following search ephemeris:

	R.A.	N. Decl.	log <i>r</i> .	log Δ.
July 17.	5 ^h 12 ^m 48 ^s	19° 38'	0.274	0.418
21.	5 22 54	19 51	0.276	0.416
25.	5 33 0	20 1	0.278	0.413
29.	5 42 54	20 9	0.280	0.411

The comet was observed in 1918 more than three months after perihelion, so its detection this year is not hopeless, though the conditions are less favourable. Since it was discovered at Bergedorf, the astronomers of that observatory (to which Mr. Larink belongs) are making special efforts to recover it.

Research Items.

STONEHENGE.—The excavations in progress at Stonehenge have now covered the greater part of the site, only the north-western area awaiting examination. The sixth report on the results, which was presented by Col. Hawley on behalf of Mr. Newall and himself at a recent meeting of the Society of Antiquaries, deals with the south and south-west area. No objects of any importance were turned up; but a number of holes, some shallow, others reaching to a depth of 28 inches and ranging in width from 15 to 23 inches, were found. These pointed to the possible existence of a stockaded passage or long roofed building at this point, and it is conjectured that they were contemporary with the causeway at the main entrance, where similar post holes have been found. Nothing of the Stonehenge period had penetrated to the lower levels. Another causeway with pits in the ditch on each side of it was exposed. Seventy-one holes in all were discovered; but it is impossible to say what their use may have been, though they were too irregularly placed and too widely spaced to have formed a building. Further investigation has shown that the area of foreign stones must have held a much larger number than had hitherto been supposed, and they must have presented the appearance of a low wall. The discovery of a seventeenth-century glass flagon suggested that the removal of these stones had been comparatively recent.

UNITS OF MEASUREMENT IN ANCIENT EGYPT.—In *Ancient Egypt* for June, Sir Flinders Petrie puts forward and discusses a suggestion by Mr. J. Tarrell to account for the fact that the varying thicknesses of the courses of the great Pyramid tend to group around certain heights. The courses a dozen times or more start with a thick course, and dwindle until a thick course occurs again. An enormous number of blocks must have accumulated in the years of preparation. When the masons were ready to build, they shifted the quarrymen to another quarry and started sorting the blocks for each course according to size. This process was repeated from time to time, each thick course representing the beginning of a supply from a fresh source. The variations in thickness suggest the use of the cubit and double cubit, 20.6 and 41.2 inches, as the unit of a great number of the blocks, with a digit measure between, the groups being at 50, 40, 30, 32 (?), 34, 36, and 38 digits. Large exceptions point to local measures which may have survived into later times: 21.3 in. is the medieval Nilometer cubit; 22.2 in. the double foot of Syria found down to Roman times; 23.2 in. the double Roman foot, an ancient measure in Etruria; 26.3 in. the double of the northern foot (the foot of Germany and the basis of measurement in England which survives in the furlong and chain, and is important in France); 28 in. the Turkish *pik*; and 38.1 in. the Persian *arish*.

THE CRYSTALLINE STYLE.—Whereas in lamelli-branches a crystalline style is common, in gastropods it occurs in only a few genera. Mr. N. A. Mackintosh has given (*Quart. Journ. Micr. Science*, March 1925) a careful description of the style of *Crepidula*—the slipper limpet. The style, which is contained in a sac partially differentiated from the intestine, is a straight transparent rod of gelatinous consistency built up of co-axial layers surrounding a spiral core. It is composed chiefly of globulin and contains an amylolytic enzyme. The style and the style-sac resemble those of lamelli-branches so closely that they must be regarded as homologous in the two groups. A list of about two dozen gastropods is given in which

the style is known to occur, and it is suggested that the style has been lost in all but a few gastropods, or that its appearance in this group is to be explained on the principle of orthogenesis.

GELATION AND SOLUTION IN CELLS.—In his report (Year Book No. 23) on the work of the Department of Embryology of the Carnegie Institution of Washington located in Baltimore, Dr. G. L. Streeter refers among other items to the work of Mrs. G. M. Lewis on gelation and solution in cells. When a culture of embryonic tissue is washed with a saline solution to which any of the ordinary acids has been added to give it a P_H of 4.6, the cells undergo coagulation and exhibit appearances which are regarded as characteristic of cell-death. The nucleus becomes granular and acquires a bright thick membrane; in the cytoplasm the granules cease their activity, and pseudopodia are not put out. If now, before the coagulation proceeds further, the acid solution is washed off, the cells recover their normal appearance, and such a culture if returned to the incubator may live as long and remain in as good condition as the controls; in other words the gelation is reversed. Such gelation can be brought about and reversed several times in succession. The cytoplasm can be made more fluid by means of a solution of alkalis with a P_H of 8.6 to 9. The cells, instead of remaining spread out on the cover glass, begin to round off, the mitochondria change from filaments to short rods and all the granules are in dancing movement. By bathing the cultures in normal solution the process can be to some extent reversed, but the cell never spreads out again, and such a culture does not live so long as the controls. One of the most effective acids in bringing about the gelation of living cells was that obtained from sterile dead tissue, and Dr. Streeter remarks that this fact should be of importance in explaining the toxic nature of crushed or burned tissue.

NUTRITION OF MYCORRHIZA PLANTS.—Dr. M. C. Rayner has published the results of further research on the nutrition of *Calluna vulgaris* (*Brit. Journ. Experimental Biol.*, vol. 2, January 1925, pp. 265-292). The most striking of these is the observation of regular and well-marked digestion of the mycelial constituents in the root mycorrhiza. Digestion begins soon after the production of young roots in the spring, is carried out throughout the growing season (during which mycelial activity reaches a maximum), and continues until growth ceases in the autumn. It cannot therefore be regarded as a phenomenon of senescence. The author shows that under certain conditions the roots may be infected by the fungus, but that typical mycorrhiza may not be established. By means of a special technique it is possible to find, in early spring especially, the hyphae of invading root cells undergoing digestion before branching of the filaments can take place in the cells. This formation of suppressed mycorrhiza is regarded as highly significant, and is held by the author to explain the discordant results of previous workers. Assuming it to be correct, "the formation of mycorrhiza is a reciprocal phenomenon involving co-operation on the part of the root cells" and "represents a temporary phase of toleration on the part of the plant cell interposed between one involving immediate destruction of an entering hypha and the wholesale digestion of the mycelium which eventually takes place." It is held, in consequence, that the obligate relation in *Calluna* is associated with fungal infection and seedling development rather than with the subsequent stage of typical mycorrhiza.

formation. The cytology of digestion, the distribution of the mycelium in the shoot, experiments with cuttings, and a general discussion on the nutritive relations in *Calluna* are other subjects dealt with in the paper.

WATER ABSORPTION BY LEAVES.—J. G. Wood has recently directed attention (*Australian Journal of Experimental Biology and Medical Science*, Vol. 2, pp. 45-56, 1925) to the remarkable capacity for water absorption possessed by the relatively uncutinised leaves of species of *Atriplex*. These plants, the "salt-bushes" of Australia, are the characteristic plants over vast areas of dry plains, and as their root system is poorly developed, this power of absorbing water by means of the leaf system may be of considerable significance. It appears to be due to a remarkable accumulation of sodium chloride in the leaves of these plants. Even when growing in soil containing relatively small quantities, considerable accumulation of the salt occurs in the plant. As the result of microscopic examination of leaves placed in a solution of silver nitrate and then exposed to light, this accumulation seems to be most pronounced in the veins and in the chlorenchyma surrounding the veins.

RADIUM ORE DEPOSITS IN CENTRAL ASIA.—The presence of certain radioactive uranium minerals in Ferghana, Russian Turkestan, has been known since the beginning of this century. The centre where such deposits have been found is the Tuyu-Muyun copper mine, where uranium was discovered long ago. More recently that mine has been studied extensively by several Russian mineralogists, geologists, and chemists, and since 1923 the mine has been regularly exploited. Results of the work of the expeditions recently published by the Russian Academy of Sciences show that the deposits are of great practical value as a source of radium; moreover, a study of geological conditions of the Ferghana province leads to the suggestion that radium deposits are not restricted to that mine only, but are much more widely distributed along the northern slopes of the Alai and Turkestan ranges. Further investigations are being carried on by the recently founded State Radium Institute of the Academy.

THE GEOLOGY OF SOMALILAND.—Mr. R. A. Farquharson's first report on the geology and mineral resources of British Somaliland, 53 pp., 1 map, forms a valuable contribution to the geology of East Africa. The report includes a general summary of the Somaliland sequence, which has recently been described in a monograph published by the Hunterian Museum of the University of Glasgow. To the sequence already known Mr. Farquharson's most important addition is that of a series of ancient unfossiliferous slates with interbedded limestones, for which he makes the interesting suggestion that they are the northern extension of the Karagwe Series of Kenya Colony and Uganda. The local Jurassic rocks he attributes entirely to the Kimmeridgian, but in the absence of any information as to the fossils he collected, it remains uncertain whether this identification is likely to stand, or whether he obtained them only from the upper part of the Jurassic. Mr. Farquharson's conclusions as to the age of some Kainozoic rocks do not agree in some respects with those based on the collections made by Messrs. Wyllie and Smellie, and an account of the author's fossils and his geological map will be awaited with interest. The longer section of the report includes an account of the occurrence of numerous economic minerals, some of which are regarded as promising, though nothing has been so far proved of

commercial value under present conditions. In some of the specimens collected by the author, assays at the Imperial Institute record a trace of gold. The report is illustrated by a map in which, unfortunately, the place names are sometimes spelt differently from those in the text. The Las Khorai of the map is apparently Las Gori of the report. It is regrettable that a report issued at the end of April 1925 should be dated as if published in 1924.

THE PETROLOGY OF SAMOA.—Prof. R. A. Daly has written a very valuable account of the geology of Tutuila and the smaller American islands of the Samoan Group for Publication No. 340 of the Carnegie Institution of Washington. The average basalt of Tutuila is almost identical with that of Hawaii and with the average plateau basalt of the world. This close resemblance of the oceanic and continental basalts is strongly suggestive of a nearly uniform substratum below the heterogeneous crust. The alkali-trachytes and other intermediate rocks, occurring in Tutuila mainly as volcanic necks and dykes, are regarded as differentiates of ordinary basalt. The cause of the differentiation is, however, recognised to be still an unsolved problem, though the common eruptive sequence—basalt, trachyte, basalt—found in very many volcanic centres, receives a suggestive explanation. One of the domes of Tutuila is built up in part of quartz-trachyte similar to that of Ascension Island. It is remarkable as one of the rare examples of a lava in the open-Pacific area containing primary quartz, and unique in being farther removed from a visible continental border than any other case yet described. It suggests to Daly that the submerged edge of Australasia may really extend as far to the east as Samoa. The lithification of beach sands is another problem which is fully discussed. The view is adopted that the formation and distribution of the "beach rock," as the firmly cemented sand is termed, are controlled by the action of the more violent storms. These are known to pile up calcareous sands over the normal beaches, and in their new position bacterial decomposition of the organic matter associated with the displaced shelf sands tends to precipitate calcium carbonate sufficiently to fix the grains. Further precipitation from the saturated tropical sea water then completes the process of cementation. Ordinary clean beach sands are not cemented because they are kept in incessant movement by wave-action.

THE RAYLEIGH SEISMIC WAVE.—Part 5 of Vol. 2 of the *Japanese Journal of Astronomy and Geophysics* contains a memoir of 93 pages by Mr. H. Nakano of the Central Meteorological Observatory, Tokyo, on the properties of the wave propagated along the surface of the earth due to some seismic disturbance in the interior. He finds that the wave does not make its appearance at the surface at a point immediately above the focus, but at distances from that point which depend on whether the originating disturbance is of the dilatational or distortional type. Its amplitude when it first appears at the surface is small and it does not attain its full value until the wave has travelled a distance along the surface which is large compared with the depth of the focus. The retardation of phase at each point of the surface is the same as it would be if the disturbance originated at the point on the surface over the source at the instant it actually originated at the source. The author hopes by a study of the laws of propagation in a laminated earth and comparison with observations to arrive at more definite conclusions as to the structure of the interior of the earth.

SURVEYS IN TIBET.—In the annual reports of parties and officers, 1921–22, which is published as a supplementary volume to the general report of the Survey of India for that year, there is a brief record, accompanied by a map, of the late Sir H. H. Hayden's surveys in Tibet in 1922. Sir H. H. Hayden, who was accompanied by an Indian surveyor, travelled through the central and south-eastern parts of the country to report on certain mineral-bearing areas for the Tibetan government. His routes lay between Lhasa and the great lakes of Tangra, Kyaring, Zang, and Nam. Altogether some 36,000 square miles were mapped on a quarter-inch scale, of which only some 4000 miles had been previously surveyed: the remainder was known only from rough route surveys of the native Indian explorers Kishen Singh and Nain Singh, and the tracks of the few European travellers who had previously succeeded in penetrating this region.

BINARY ALLOYS OF ANTIMONY AND BISMUTH.—The equilibrium diagram of the binary alloys of antimony and bismuth has been already studied by several investigators. The results, however, do not agree well with one another, and a re-determination of the diagram has been carried out by Otani at the Research Institute, Sendai (Report No 91). He has determined the liquidus and solidus by measurements of electrical resistance. With regard to the former, he measured the difference in potential between two fixed points in the specimen, both in the liquid and solid states. The current passed through the specimen for the measurement of the potential fall was 1.5 amperes, and the electrodes dipped into molten alloys were iron wires about 0.8 mm thick. The rate of heating and cooling was about 1 degree per minute. The liquidus curve is found to be smooth and convex upwards. In the case of the determination of the solidus, the alloys were tested in the form of rods 5 mm. thick and 9 cm. long. These rods were made by casting the alloys in an iron mould and afterwards annealing them just below their solidus for a sufficiently long period to obtain a homogeneous structure. This was confirmed by microscopical examination. The temperature-resistance curves obtained on heating show that the solidus also is a smooth curve, which is concave upwards. The crystallisation interval in the case of the 50:50 alloy is nearly 200° C. This, of course, diminishes on either side. Thus the form of the liquidus and of the solidus in this system belongs to the ordinary type of solid solution where all points of the liquidus lie between those of the pure metals.

THE CURRENTS IN SUPRACONDUCTORS.—Supplement No. 50 of Communications from the Physical Laboratory of the University of Leyden contains a report by Prof. Kamerlingh Onnes of the results of the experiments on the mutual action of the electric currents in two superconductors in the neighbourhood of each other. In one case the two superconductors are concentric rings of lead in liquid helium with their axes horizontal and the inner ring supported by a long vertical fibre provided with a torsion head. The currents having been produced in the rings by the diminution of a magnetic field along their axes, the inner ring is rotated about 30° out of the plane of the outer by means of the torsion head. The rotation of the inner ring is observed by means of a mirror attached to it and is found to be invariable to within less than 1 part in 1000 for 6 hours. When the inner ring is replaced by a spherical shell also of lead and the experiment repeated, the torsional couple necessary to rotate the sphere is only one-third that for the ring. The author concludes that the paths of the electrons amongst the molecules of matter are fixed and unaffected by any transverse magnetic field.

DOMESTIC GRATES.—Technological Paper No. 13 of the Fuel Research Board is an account of the investigation of the relation between the design of a domestic grate and the heat radiated by it into the room, carried out by Dr. Margaret Fishenden under the auspices of the Manchester Air Pollution Advisory Board. The measurements show conclusively that diminution of the depth of a grate from front to back increases the heat radiated into the room per pound of coal consumed. Ease of maintenance of the fire limits this diminution in most cases to a minimum of four inches. The bars of the grate should be as slender as possible, and the grate should be visible from as large an area of the floor of the room as possible. Conduction losses through the back of the grate should be minimised by the use of firebrick instead of iron. The throat of the flue should be adjustable in area so as to permit regulation of the flow of air through the room, and an adjustable air inlet beneath the fire should be provided for the regulation of the speed of combustion of the coal.

PRECIPITATION OF RADIUM SULPHATE.—Sulphate ions will precipitate radium in the presence of a large excess of barium even though the solubility product of radium sulphate is not exceeded. H. A. Doerner and W. M. Hoskins have investigated this phenomenon and publish their results in the *Journal of the American Chemical Society* for March. At equilibrium, the reversible reaction



gives a distribution of radium and barium represented by the equation

$\text{Ra}''(\text{final}) \times \text{Ba}''(\text{initial}) = K \times \text{Ra}''(\text{initial}) \times \text{Ba}''(\text{final})$, which is mathematically deduced from the principle that the radium-barium ratio of the precipitate ("crystal surface") is proportional to the radium-barium ratio of the solution. This equation is confirmed experimentally, K , obtained by several methods, being 1.8. The equilibrium is largely influenced by crystal growth. The possible application of the theoretical equations to adsorption, fractional crystallisation, etc., is discussed.

SOLID SOLUTIONS OF WATER AND OXYGEN.—The attention of chemists so far has been centred chiefly on compounds subject to the law of multiple proportions, but, according to N. S. Kurnakov (*Annales de l'Institut d'analyse physico-chimique de l'Académie de Science de Russie*, vol. 2, liv. 2, 1924), we must admit that this type of change is merely a particular case of a more general case—the constant change of the solid phase. Attention is directed chiefly to the ferrous compounds with a variable amount of oxygen and water in such substances as mica, tourmaline, hornblende, and also phosphorus salts. For these substances, the absorption of different amounts of oxygen does not affect the structure of the crystal, but creates continuous variations of colour and optical properties. The greyish-black, bluish-green, and blue colour of such substances is remarkable as being doubtlessly connected with the amount of absorbed oxygen. A very characteristic example is the mineral vivianite, which is a hydrated phosphorus oxide of iron, which may also be produced synthetically. In the early stages of their formation the crystals are nearly colourless, but become more blue as oxygen is absorbed, without changing their structure, and remaining quite homogeneous. The amount of water in vivianite crystals is also variable; the latter depends on the formation of solid solutions of water, and is very common among numerous classes of chemical compounds.

The Imperial Entomological Conference.

THE second Imperial Entomological Conference, which was summoned by the Secretary of State for the Colonies at the instance of the Imperial Bureau of Entomology, was held in London on June 9-18, and was attended by twenty-one delegates, representing the governments of most of the British Dominions and Colonies. The delegates were received by Earl Buxton, chairman of the Committee of Management of the Bureau, at Burlington House, where the meetings were held. They were also invited to a reception at the British Museum (Natural History) and to meetings of the Zoological and Linnean Societies, and were given the opportunity of visiting Oxford and Cambridge, and the Rothamsted Experiment Station and the Ministry of Agriculture's Pathological Laboratory at Harpenden.

The public meetings of the Conference occupied four days, one of which was largely devoted to the general aspects of applied entomology. Dr. G. A. K. Marshall, Director of the Bureau, read a paper on "The Aims and Organisation of Economic Entomology." After briefly reviewing the steadily increasing importance of tropical agriculture as a source of the world's food supply and raw materials, he said that the economic effect of insect pests is not fully realised. The suggestion sometimes made that crops that suffer severely from pests in a given country should be abandoned in favour of others is not feasible in the case of essential crops, and as the world's population increases, it will become more and more necessary to protect them from insect pests.

The present organisation of economic entomology is unsatisfactory. Economic entomology should be preventive, but a government entomologist, responsible for a huge area of country, cannot hope to do more than wait to be called in by planters for advice, which only happens when an outbreak of a pest is well under way, and its control has become difficult, if not impossible. What is required is that the planters should themselves employ their own entomologists, who would be continually working on the problems of their special crops, and would take steps to prevent outbreaks of pests from arising. This would effect an enormous saving, and should be regarded as a form of insurance. The Hawaiian Sugar Planters' Association affords an excellent example of how a scheme of this sort should be put into practice. The government entomologists would then be free to undertake research.

Dr. T. W. Munro gave an account of the organisation of forest entomology in England, and in the discussion that followed, the various systems of economic entomology at home and in a number of the Dominions and Colonies were described. A point strongly emphasised here, and also at the other meetings, was the diversity of problems presented, not only by the obvious differences of climate, crops and pests, but also by the great differences in the populations concerned. Thus in Egypt, where agriculture is chiefly in the hands of the illiterate classes, measures against insect pests are not only organised, but also actually carried out, with excellent results, compulsorily by the government, the growers paying the bulk of the cost; whereas, at the other end of the scale, in South Africa all that is necessary is for one of the more progressive men in a district to be shown what to do, the others being only too glad to imitate his work.

In discussing the qualifications of an economic entomologist, Mr. H. H. King pointed out that he must not only have had the necessary scientific training, but must also have personality and a know-

ledge of men, so as to be able to convince those with whom he has to deal that they would benefit by carrying out the measures he suggested.

Several of the meetings were devoted to pests of particular crops and other aspects of economic entomology in the various colonies, and a great deal of valuable information was interchanged; but they were, of course, of rather specialised interest. Perhaps the most important discussion of the meetings, however, particularly in view of the reports of the East Africa Commission and of the League of Nations Conference on the subject (*NATURE*, June 27, p. 985), was "Co-ordination of Effort in Tsetse-fly Investigations." The chair at this meeting was taken by Mr. W. Ormsby Gore, Under-Secretary of State for the Colonies. In opening the discussion, Prof. Warrington Yorke said that the problem is not purely entomological, but comprises four factors, namely, the trypanosomes concerned, the population and domestic stock, the transmitting agent or tsetse-fly, and the reservoir of the virus, or big game. An advance can only be made by taking into consideration at the same time and in the same locality all these factors. In short, he advocated centralisation of effort. Much of the scattered work at present being carried out is failing to produce satisfactory results owing to its being misdirected, to lack of continuity and to lack of funds. He thought, however, that the International Commission suggested by the Sleeping Sickness Conference that met in May under the auspices of the League of Nations was premature, and that knowledge is not yet sufficiently advanced for regulations to be formulated governing the international frontiers of tropical Africa. More is to be hoped for from an inter-colonial conference, by means of which the work of entomological, medical and veterinary research could be combined under one central organisation, supported by pooled contributions of all the colonies interested.

Mr. C. F. M. Swynnerton agreed that co-ordination between the different branches of science was very necessary, but considered that a central organisation would meet with almost insuperable difficulties. He pointed out that there are twenty species of tsetse-fly, each having its own requirements in the matter of habitat and possibly fauna, and also occurring in a variety of combinations. There are thus probably fifty different tsetse-problems in different parts of Africa. Each colony should have its own department for the subject; touch should be maintained between the colonies by mutual visits and, if possible, by a travelling director who should go from colony to colony. He described the work in Tanganyika Territory, an account of which has already been given in *NATURE* of March 7, p. 338, and showed how co-operation has been obtained not only among the various scientific departments, but also with the natives themselves. International and inter-colonial co-operation must be provided for, as the problems are often the same on different sides of political boundaries. He does not consider measures against game justifiable in the present state of knowledge; and even if they proved to be so, they would be very difficult in practice. He gave instances of cases in which they have actually defeated their own object.

Dr. A. Balfour agreed with the need for inter-colonial co-operation, but considered that, as the problems in the east and west of Africa are so different, and intercommunication so difficult, it might be better to have two organisations instead of the single one suggested by Prof. Yorke.

Major E. E. Austen objected to Prof. Yorke's unqualified statement that game is the reservoir of sleeping sickness. He supported the idea of an International Commission, for, in the special problems to be dealt with, political boundaries are often not natural ones. He emphasised the multiplicity of the problems presented by the various species of tsetse-fly and the consequent need for attacking them by every feasible method. Dr. A. G. Bagshawe pointed out that it is only within the last two years that we have been shown by Mr. Swynnerton that valuable land can actually be recovered from the fly. All efforts should be concentrated on making this work a success on a larger scale. Dr. G. A. K. Marshall observed that trypanosomiasis has to be dealt with on two main lines: the attack upon the disease, and the attack on the flies. A single comprehensive investigation in one place may be excellent on the medical side, but on the entomological side there are numerous problems that can only be solved by investigations in many different localities. While on the medical side further extensive research is the primary need, this is not the case on the entomological side, at least in those countries where the advance of the flies constitutes a dangerous menace. Here the primary need is for an immediate direct attack upon the flies by methods similar to those so successfully employed by Mr. Swynnerton, accompanied by appropriate research. One great difficulty in the past has been procuring the necessary funds; and the

reclamation of valuable land by a direct attack on the fly is more likely to appeal to the governments and commercial interests concerned than any programme of purely scientific research.

The chairman supported the idea of an International Commission as proposed by the League of Nations Conference, not only from the scientific point of view, but also from that of educating the general public and the administrators. Money is essential, and public interest must be directed to the economics of the problem. From this point of view the veterinary side is of enormous importance. A scheme that suggests the killing of big game when the smaller animals would remain is contrary to common sense, but a practical policy, such as that of Mr. Swynnerton, should obtain public support.

Before the Conference ended resolutions were passed recommending, among other things, that a similar conference should be held in London every five years, that meetings of entomologists and other scientific officers should be held in the Dominions and Colonies for the discussion of mutual problems; and that the work of the Imperial Bureau of Entomology should continue on the present lines and be somewhat extended in connexion with the export to Oversea Governments of beneficial parasites.

The Conference concluded with a dinner given by the Government in honour of the delegates, at which Mr. L. C. M. S. Amery, Secretary of State for the Colonies, presided.

Photographic Studies of Solar Prominences.¹

THE invention of the spectroheliograph, more than thirty years ago, made it possible to study in detail photographs of the prominences, those strange and beautiful forms rising from the chromosphere which were first made familiar to readers of NATURE by the drawings of Lockyer in the 'seventies. Systematic photographic work does not appear to have been initiated until it was taken up at Kodaikanal in 1905, and the Rumford spectroheliograph appears also to have begun recording prominences at about this period; but until recent years very little has been published regarding their movements. This is no doubt largely due to difficulties imposed by atmospheric conditions, for it is very rarely possible to secure a series of photographs of the same prominence at short intervals of time and with equally good definition in all the images. In the memoir under notice this is apparent in the statement that in about 4000 plates examined "very little material suitable for the study of the motions of prominences was found." We must congratulate Mr. Pettit on the very interesting results he has nevertheless extracted.

The work relates very largely to the eruptive prominences, which are defined as "those which rise from the chromosphere in a more or less vertical direction, and are dissipated in space at enormous altitudes." It had already been shown by observers of eruptions that the velocity of ascent increases with the height, and photographs of prominences of this class obtained at Kodaikanal and in Kashmir appeared to show a continuously accelerating velocity, indicating a force of repulsion from the sun, analogous to that which gives an accelerating velocity to the gases in comets' tails. The author, however, from a careful study of the great prominence of May 29, 1919, considers that the force in this case was discontinuous, the outward velocity increasing by a series of sudden

impulses, between which the motion was uniform. Other prominences observed later also displayed this very remarkable characteristic, and Mr. Pettit was led to examine all recorded observations of eruptive prominences, visual and photographic. The results are set out in 24 diagrams, giving the heights as ordinates and times as abscissæ. The evidence as thus presented appears strongly favourable to the principle of uniform motion and sudden impulses; for many of the diagrams indicate this very clearly, although others, e.g. No. 22, would seem to indicate a continuous acceleration. Of three cases which come within the knowledge of the writer of this notice, two decidedly favour continuous acceleration. These are numbered 8 and 9 in Fig. 3. In No. 8 there is an error in the height given at 9 h., which should be 110,000 instead of 130,000 km. By substituting this height in the diagram, it appears that a continuous curve would better fit the observations than that shown. In the case of the prominence of May 26, 1916 (Fig. 3, No. 9), measures of the negatives published in Kodaikanal Observatory Bulletins III., 215, are not used in the plot, but instead a set of measures from half-tone prints. Had the original measures been used, a continuous curve would have resulted. Evidence in favour of uniform motion is admitted in the case of No. 24, which was photographed at Kodaikanal, but here the time interval is short, and no change of velocity is indicated from three observations of the height.

Obviously this question of the character of the motion is of the greatest interest and significance, and it will no doubt be exhaustively studied in future eruptions.

The material supplied by the Rumford spectroheliograph has enabled Mr. Pettit to study successfully both lateral and internal motions of prominences. Lateral motions are defined as "the motions of prominences which rise from the sun's surface, and, passing over a trajectory, generally re-enter the chromosphere." A very curious example is recorded

¹ "The Forms and Motions of the Solar Prominences." By Edison Pettit. Publications of the Yerkes Observatory, vol. 3, part 4, University of Chicago Press.

dealing with rest pauses, repetitive work, and posture; and two other reports have been issued, one presenting a synopsis of the results of the Board's previous investigations in various industries, and the other describing the uses and limitations of statistical methods in such research.

Those who are unacquainted with these and with the twenty-four earlier reports of the Board will obtain an excellent idea of the Board's invaluable work by a study of this annual report. The special contributions by Mr. Wyatt, Miss May Smith, Mr. Farmer, Miss Newbold, Dr. Vernon, and Mr. Weston concern learning curves in industry, exceptional work curves, differential tests in relation to proneness to accidents, sickness statistics, the significance of output, and the value of personal evidence in the investigation of industrial efficiency. These well illustrate the various problems and difficulties with which the Board is confronted. The numerous investigations and committees of the Board, and the extremely interesting and lucid language of the annual report, bear testimony

to the devotion, ability, and organising power of its secretary, Mr. D. R. Wilson.

The survey, with which the Report concludes, of the past activities and of the present position of the Board is especially noteworthy. Stress is there laid on the fact that such indications "as emerge from the investigations undertaken by the Board and the National Institute of Industrial Psychology are surely worthy of serious attention on the part of industry, if only for the reason that, from the very method of their assessment, strong evidence exists that they will benefit the employer no less than the workman." It is surely lamentable, then, to read on pp. 16 and 17 of the Report that the Jute Spinners and Manufacturers' Association recently declined "to participate in any inquiry or even to afford facilities for a preliminary survey" by the Board in that industry, although the Board had been expressly invited by the Jute Trade Board to undertake an investigation into the effects of fatigue, and the workers desired that it should be carried out.

Rothamsted Experimental Station.

OPENING OF THE PLANT-PATHOLOGY LABORATORIES.

THE annual meeting of the subscribers to the Society for extending the Rothamsted Experiments was held on Thursday, June 18, when at the invitation of Lord Clinton, chairman of the Lawes Agricultural Trust, about sixty members and visitors attended.

In the morning the experimental fields were inspected. As for some years past the total number of plots has exceeded 500, it is usual to select for the annual inspection a limited set illustrating one or two special points. On the present occasion a series was chosen to illustrate certain contrasts between modern and early methods of planning field experiments. Lawes' and Gilbert's early field experiments were laid out on the parallel strip system, the best known example being the classical Broadbalk field which has grown wheat every year since 1843. The strip system was simple and straightforward, and adequately showed up the large differences in yield between the various manurial dressings, especially when the experiment was repeated over a large number of years to eliminate the variable effect of season. The next stage was the "chess-board" plan in which the parallel strips of plots receiving different manures were crossed at right angles by strips of other manures. This method was adopted in the Hoos field permanent barley experiments commenced in 1852, and the arrangement permits of a greater number of comparisons between given manures, alone, and in various combinations.

Many of the broad generalisations, now an integral part of farming practice, were developed from the Broadbalk and Hoos experiments. These two fields are still giving exceedingly valuable information, but they are not suitably arranged to provide definite answers to many modern problems, in the majority of which the maximum difference expected between control and treated plots is a few bushels of corn or hundredweights of roots. It therefore becomes essential to reduce the experimental error as much as possible. The first step is to have a considerable number of small plots under each treatment, and to harvest each plot separately. Further, in order to allow for the inherent variation of fertility in the land, the results are examined by statistical methods devised specially for this purpose. It is an essential condition of such an examination that the plots should be distributed not systematically but at random. From the viewpoint of visitors this com-

plicated system is perhaps not so striking as the older plots, but it has the great advantage of giving a reasonably accurate result in a fairly short period of time. As an illustration of the method, the visitors were shown the experiments on the effect of varying the amount and time of application of nitrogenous top-dressings to the oat crop.

After lunch, Lord Clinton in a short address referred to the close touch now maintained between agricultural research institutes and modern farming problems, and to the facilities for the fundamental study of plant diseases now available at Rothamsted. Sir John Russell then gave a brief account of the type of problem that would be investigated in the new laboratories, and also directed attention to the economic importance of such work.

Lord Bledisloe expressed his pleasure at being invited to perform the opening ceremony of the new plant-pathology laboratories, because they were erected during the period when he was chairman of the Lawes Trust. In reviewing the history of the Station, he was impressed by the rapid application to farm practice of the results obtained by Lawes and Gilbert. As a result the wheat production increased in twelve years from an average of 22 bushels to 32 bushels per acre. He was further impressed by the loss sustained by farmers due to pests of various kinds attacking the crops. Although it was not easy to arrive at an accurate estimate of such losses, the most reliable figures put it at no less than 10 per cent. of the total value of crops in Great Britain. It was evident that the Ministry of Agriculture, in defraying the cost of erection and equipment of the extensive new plant-pathology laboratories at Rothamsted, were alive to the importance of research work in plant diseases. He had great hopes that effective preventive and remedial measures would soon be developed as a result of the facilities now provided.

At the conclusion of the address Sir Thomas Middleton moved a hearty vote of thanks to Lord Bledisloe, who afterwards unlocked the door of the new building. Members of the entomological and mycological departments then conducted the visitors around the laboratories. In addition to a range of research laboratories, there are a number of rooms for special operations, such as pure culture and constant temperature work, and a separate building fitted up for use as an insectory.

University and Educational Intelligence.

CAMBRIDGE.—The Harkness Scholarship for geology is awarded to A. J. Galloway, King's College, the Frank Smart Prizes are awarded to A. R. Clapham, Downing College, for botany, and to G. E. Hutchinson, Emmanuel College, for zoology, the Wiltshire Prize for geology is awarded to M. Black, Trinity College.

Sir David Lionel Goldsmid-Stern-Salomons, Bart, has left by his will 5000*l.* to Gonville and Caius College for the fund for increasing the College buildings, and 1000*l.* to augment the Salomons Engineering Scholarship Fund. He has left to the University all his scientific instruments and medical apparatus, all models and human specimens suitable for instruction, his collection of crystals and other apparatus used for polariscope work. The Broomhill magnet and the apparatus with it is bequeathed to the Royal Institution, London.

ST. ANDREWS.—The honorary degree of LL.D. has been conferred upon Prof. F. G. Donnan, professor of inorganic and physical chemistry in the University of London, and upon Mr. R. T. Gunther, fellow of Magdalen College, Oxford.

THE Medical Research Council has awarded Rockefeller Medical Fellowships, tenable in the United States of America during the academic year 1925-1926, to the following: Dr. D. Campbell, Pollok lecturer in pharmacology and therapeutics, University of Glasgow; Mr. W. H. Craib, house physician, Guy's Hospital, London; Dr. Katherine H. Coward, assistant in biochemistry, University College, London; Mr. W. S. Dawson, senior assistant, Maudsley Hospital, London; Mr. H. W. Florey, John Lucas Walker Student, University of Cambridge; Mr. A. D. Ritchie, lecturer in physiological chemistry, University of Manchester; Mr. G. P. Wright, Macgregor Student and demonstrator in histology, University College, London. Dr. Craib, Mr. Florey and Mr. Ritchie have been appointed on modified conditions while holding scholarships or emoluments from other sources. Mr. Ritchie's fellowship is being held during a short period of work in Canada this summer.

FISCAL support of State universities and State colleges is discussed in great detail in Bulletin, 1924, No. 28 of the United States Bureau of Education. There is great variation as between the different institutions in the ratio between student fees and State appropriations. In 1921 the University of Texas received eleven dollars through State appropriations for every dollar received from student fees, while at the University of Wisconsin the ratio was $2\frac{1}{2}$ to 1. The line between free public higher education and payment of part of the cost by the student has been generally lowered during the past twenty years from the beginning of the professional courses to the beginning of the undergraduate courses, and the tendency of fees for both academic and general and professional courses is to increase. The writer of the bulletin assumes that the State universities will profit much from gifts of alumni for special purposes as they become older, but it does not now appear that they can hope to meet a large part of their operating expenses from endowments, the brunt of which will continue to fall on the State and the students.

ERRATUM.—The name P. R. Cuvati in the issue of June 27, p. 997, col. 1, line 6, should be P. R. Awati.

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Early Science at Oxford.

July 6, 1686. Some of ye Society gave an account that about noon that day, they saw *Venus* near ye Moon without ye help of a Telescope, when the Sun shone very clearly, and that many people in ye streets observed ye same thing.

Then was read a specimen writ by Mr. John Adams (who has allready spent diverse years in a general Survey of England) concerning the *descriphon* of particular *parishes*, who desired ye opinion and advice of ye Society what therein may be fit to pursue, what to omit of it, or what other remarks to adde.

July 8, 1684. An account of ye weather at Dublin, in May last, taken, in a scheme according to Dr. Lister's Method, by Mr. Molineux, was presented by him to this Society. Ordered, that ye thanks of this Society be returned to Mr. Molineux for this Obligation. A Letter from Mr. Maunders, dated July 2, and giving an account of ye very great damage, lately done, to some parts of Somersetshire, by caterpillars, was read.

An account of a monstrous child, born, not long since in Jutland, with 2 draughts of that Child were presented.

Two letters written, some years since, by Mr. Lister, to Dr. Oldenborough were read: one concerning ye great age of severall persons in Craven, ye other concerning ye projection of ye threds of Spiders, and of bees breeding in cases made of leaves; as also concerning a viviparous flye. Mr. Todd promises an account of ye most aged persons in Cumberland, and Mr. Crouch, at ye request of ye Society, engages to examine ye Register which gives an account of Mother George's age.

A Paper was presented, containing ye design of some learned Gentlemen in Somersetshire, to write ye naturall, civil, and ecclesiasticall History of that County.

July 13, 1686. In a letter to Mr. President, Mr. Halley promises to send an extract of ye Journal of ye Royal Society for ye time we want it, and for ye future to send us once a fortnight what shall occur there. In a second letter he gives an account that ye Royal Society will allow him £50 to measure a *degree* of ye earth, and that he intends to take ye latitudes with an instrument of 20 foot radius, with telescopic sights. He adds that he has seen a Calico shirt brought from India which is *woven* without a seam all of one peice.

July 14, 1685. After some interruption of our meetings by reason of ye Rebellion, on this day, (Dr. Smith being in ye Chair), three letters from Mr. Aston were read.—The ways of making Prince's metall mention'd in ye letter of July 2 were ordered to be tryed, which Mr. Ballard undertook to do.

Mr. St. George Ash, Secretary of the Dublin Society, sent ye Minutes of that Society for ye month of June: together with a paper enclosed in it, drawn up by Mr. Smith, Fellow of Trinity College, by way of answer to Mr. Molyneux's Quæries concerning Lough-Neagh, which paper with very good reason ascribes a petrifying quality to ye Earth, but not to ye Water of that Lough. The thanks of this Society were ordered to Mr. Ash and Mr. Smith for these communications.—Mr. Aland's discourse concerning ye longitude, and an account of ye monstrous fish mentioned in ye Dublin Minutes, are desired to be sent us.

Dr. Cony presented ye Society with a telescope in ye name of Thomas Hardresse of Rochester Esqr. Ordered that ye Secretary send ye most humble thanks of this Society to Mr. Hardresse for this very generous present, and that it be carefully preserved in their Repository.

Societies and Academies.

LONDON

Royal Society, June 25 — D. H. Black β ray spectra of thorium disintegration products. Using comparatively strong sources of thorium-B in equilibrium with thorium-C and thorium-D, the β ray spectra of these substances have been re-measured in order to bring them into line with the standard spectrum of radium-B. Several new lines were found. Of these, one group is of great interest on account of the fact that, despite their high energy (2.5 million volts), they are due to the expulsion of electrons from the *K*, *L*, and *M* levels of an atom by one γ ray — C. F. Elam. Tensile tests of crystals of an aluminium zinc alloy. The crystals, containing 18.6 per cent zinc, resemble pure aluminium in structure and contain the zinc in "solid solution". They are harder and less ductile than pure aluminium. Fracture occurs on one or more planes at approximately 45° to the axis. These planes are closely related to crystallographic planes. Slip planes are sometimes parallel to planes of fracture — G. Shearer. On the distribution of intensity in the X-ray spectra of certain long-chain organic compounds. In the X-ray "spectra" of substances the molecules of which contain long open chains of carbon atoms, there is a certain large spacing corresponding to planes at distances apart closely related to the length of a single molecule or of two, end to end. A large number of successive orders of reflection from this plane can be observed, and their distribution of intensity is calculated on certain simple assumptions as to the distribution of scattering material along the length of the molecule. It is thus possible to fix with reasonable accuracy the position in the chain of the CO group in such series as the ketones and the esters, this appears to open up a new application of X-ray methods to chemical analysis. Further work on these lines may throw light on the relative scattering power of the various atoms and atomic groups. — C. F. Jenkin. High-frequency fatigue tests. High-frequency fatigue tests on copper, Armco iron, and mild steel were obtained at frequencies so high as 2000 periods per second, and unsuccessful experiments were made up to 5000 periods per second. There is a small rise in the fatigue limit as the speed is increased. The dependence of the fatigue limit on the frequency has, however, an important bearing on the theory of fatigue failure. The term "fatigue limit" is used here to denote the greatest alternating stress which can be applied to a material for an indefinitely large number of periods without causing fracture. — L. W. Bryant and D. H. Williams. An investigation of the flow of air around an aerofoil of infinite span. The stream-lines deduced were compared with those for inviscid flow obtained by means of an electric tank in which the equipotential lines were equivalent to stream-lines in a perfect fluid. Except for a narrow trailing "wake," the lines of viscous flow approximate to those for an inviscid fluid, when a circulation equal to that experimentally determined in the wind tunnel is superposed upon the flow around the aerofoil without circulation. The boundary layer around the nose and over the under surface of the aerofoil is very thin. Velocities deduced from observed pressures on the surface agree very well with velocities measured in the free stream, except over the upper surface, where "wake" begins to develop — G. I. Taylor. Note on the connexion between the lift of an aerofoil in a wind and the circulation round it (Appendix to

preceding paper). The connexion between the lift force on an aerofoil and the circulation round it is independent of the contour chosen if the flow is irrotational, and also if the flow is not irrotational provided that a special type of contour is used, according to Messrs Bryant and Williams. Their contours happen to be of the special type, so the accuracy with which the observed lift force agrees with that predicted from measurements of circulation is no indication that the flow is in fact an irrotational motion with circulation — T. H. Havelock. Wave resistance the effect of varying draught. The effect of finite draught is considered, in particular, calculations are made when the ratio of draught to length is one-twentieth and one-tenth, a range which covers approximately ship models. The theoretical curves show a reasonable agreement with experimental results — C. V. Raman and L. A. Ramdas. The scattering of light by liquid boundaries and its relation to surface tension. Part III — W. H. George. An electrical method for the study of impact applied to the struck string. The two impinging bodies close, during the impact, a simple electrical circuit which includes an oscillograph. From the current variations shown in the oscillograph record, the variations in mechanical pressure during the impact is derived. With a struck string there are important fluctuations in the pressure between the hammer and string, depending markedly upon the position of the striking point along the string. At some places there is a momentary complete separation of hammer and string. These results are inconsistent with the older theories of the struck string, but are consistent with the newer theories. The ballistic galvanometer method to determine the duration of the impact upon the struck string is, in general, invalid — F. H. Constable. The mechanism of catalytic decomposition. A quantitative theory based upon the series of papers entitled "The Catalytic Action of Copper" (Proc. Roy. Soc. A, vols 98 to 107) is developed. The dehydrogenation of alcoholic substances by copper occurs in stages. Reaction only occurs in a unimolecular layer in which the $-\text{CH}_2\text{OH}$ groups are in contact with the copper surface. Activation of the alcohol molecule by the catalyst consists in increasing the distance between the H atom and the O atom in the hydroxyl group. Quantitative treatment from this point of view leads to results which are not in accord with experiment. Application of the theory of probability to the conception of a "reaction centre" enables the number of centres present to be connected with the heat of activation of each by an exponential relation. The equation obtained is in accord with experience in so far as it can be tested — S. A. Emerson and L. C. Martin. The photometric matching field. — II. Peripheral stimulation of the retina with white light may cause a reduction in the limen of contrast perception at the fovea. With monochromatic lights, using the same wave-length in centre and surround, initial reductions followed by a rise in the limen are found with increasing brightness of surround at all wave-lengths, but the reductions are small in the red as compared with the blue end of the spectrum. The effects may be partly due to reflex actions associated with the retinal rods — G. S. Adair. Partial osmotic pressures and membrane equilibria. Methods for calculating partial pressures are described, based on a long unrecognised equation for membrane equilibrium, developed by Gibbs. The modified form of Dalton's law applies to certain haemoglobin solutions over a wide range of concentrations, not necessarily restricted to the very short range where the pressure is proportional to the concentration. The partial

osmotic pressure of hæmoglobin is related to the concentration by a form of Van der Waals' equation.—Mary W. Porter: A contribution to the study of the optical properties of mixed crystals. In mixtures of ammonium- and rubidium-magnesium chromates. (1) Variation of principal refractive index for vibrations along the symmetry axis is directly proportional to composition as expressed in volume or molecular percentage. (2) The other two principal indices are also continuous functions of the composition, but are not directly proportional. The general result extends the work of Lavenir and Dufet on orthorhombic mixtures.—H. Gregory and C. T. Archer: Experimental determination of the thermal conductivities of gases.—D. B. Deodhar: On atmospheric radio-activity and Indian weather.—J. R. Partington and A. B. Howe: The ratio of the specific heats of hydrogen. The determination of the ratio of the specific heats of hydrogen was undertaken by a method of adiabatic expansion previously used with air and carbon dioxide. The mean of nine determinations with pure hydrogen at atmospheric pressure and temperature gave $\gamma = C_p/C_v = 1.4113$, and the values of C_p (4.832 gm. cal.) and C_v (6.820 gm. cal.) were calculated from this value and $C_p - C_v = 1.9875$.—A. Cary and E. K. Rideal: The behaviour of crystals and lenses of fats on the surface of water.—Part I. In the process of "surface spreading," on water and solutions of N/100 hydrochloric acid, of organic compounds containing a long chain terminating in a polar group, unimolecular films spread from crystals as well as lenses, a definite equilibrium surface tension or two-dimensional pressure, characteristic of the compound in question, being established. Spreading oil films appear to be pushed out from the source (lens or crystal) by the further entry of molecules into the surface layer, rather than pulled out over a surface by the attraction of the uncontaminated water.—G. H. Henderson: The capture and loss of electrons by α particles. Singly charged α particles were measured by an ionisation method. The ratio of doubly charged to singly charged particles in equilibrium is the same in different materials, such as gold, mica, aluminium, etc. With this ratio for any material expressed as the n th power of the velocity, the value of n increased as the velocity decreased.—A. S. Parkes: The effects on fertility and the sex-ratio of sub-sterility exposures to X-rays.—R. N. Chrystal: The genus *Dreyfusia* (order Hemiptera, family Chermesidæ) in Britain and its relation to the silver fir.—T. Moran: The effect of low temperatures on hens' eggs.—T. C. Angus: The electrical characteristics of an arc lamp (direct current) measured by biological effect.—R. J. Lythgoe and J. R. Pereira: Muscular exercise, lactic acid, and the supply and utilisation of oxygen.—Part XI. Pulse rate and oxygen intake during the early stages of recovery from severe exercise.—J. R. Pereira: Muscular exercise, lactic acid, and the supply and utilisation of oxygen.—Part XII. A note on the technique of determining the resting oxygen intake while breathing concentrated oxygen mixtures.—Mary E. Laing: The composition of soap films.—G. R. Goldsbrough: Torsional vibrations in reciprocating engine shafts.—D. Brunt: Periodicities in European weather.—S. Barratt: The absorption spectra of mixed metallic vapours (II).—S. R. Savur: On the stress-optical effect in permanently overstrained celluloid.—O. W. Richardson: Structure in the secondary hydrogen spectrum (II).—A. Cary and E. K. Rideal: The behaviour of crystals and lenses of fats on the surface of water (II. and III.).—J. E. Jones and P. A. Taylor: Some theoretical calculations of the physical

properties of certain crystals.—C. Chree: The relationship between the "solar constant" and terrestrial magnetism.—J. A. Carroll: The vacuum spark spectra of some of the heavier elements and series classification in the spectra of ionised atoms homologous with copper, silver, and gold.—Sir J. C. Bose: Physiological and anatomical investigation of *Mimosa pudica*.—J. F. Fulton: Fatigue and plurisegmental innervation of individual muscle fibres.—G. Matthai: Colony formation in astræid corals (I).

Royal Anthropological Institute, May 19.—R. Ruggles Gates: Mendelian inheritance in man. Many abnormalities in man are inherited as simple Mendelian differences, and this is to be expected, since they must have arisen as single mutations. Such are brachydactyly and many other digital abnormalities, which are usually inherited as dominant characters. There is evidence that even slight abnormalities may sometimes be lethal in their effects when present in the homozygous condition. Cataract is usually inherited as a dominant, while such conditions as albinism and alkaptonuria are recessives. Colour-blindness, hæmophilia and some other conditions are usually sex-linked in inheritance, their history following exactly the course from generation to generation taken by the sex chromosomes. But various exceptions are found; and the same character may be differently inherited in different families, according to which part of the germ plasma was originally altered. The cephalic index has long been regarded as an important racial character. Recent investigations of Frets, Hildén, and others lead to the view that multiple, cumulative size factors are involved and that brachycephaly in general is dominant over dolichocephaly. Age, sex, nutrition, stature and climate affect the head form. Interracial crosses appear frequently to give 2-peaked curves for cephalic index in later generations. Records of crosses between Indians and whites, obtained in Northern Ontario, indicate that skin-colour segregates and that eye-colour is inherited independently of skin-colour.

PARIS.

Academy of Sciences, June 2.—A. Haller and F. Salmon-Legagneur: The action of methyl magnesium iodide on the esters of the α -mononitrile of camphoric acid. When the reaction takes place in etherial solution the corresponding tertiary alcohol is produced. In toluene solution the nitrile group also takes part in the reaction, a ketone-alcohol being produced.—H. Vincent: The plurality of the toxins of the coli bacillus and the experimental bases of anticolibacillus serotherapy. Evidence is given of the existence of toxins of *B. coli communis*, differing in their thermostability and action on animals.—de Sparre: The velocity of propagation of the ram stroke in armoured concrete mains.—Amé Pictet, Werner Scherrer and Louis Helfer: The presence of argon in the gases from the alcoholic fermentation of glucose. Observations are given showing that in the alcohol fermentation of glucose, argon is evolved. It remains to be proved if this gas pre-exists in the yeast and in what form.—C. Sauvageau: The development of *Leathesia difformis*.—Benjamin Jekhowsky: The generalisation of Cauchy's numbers.—Stefan Banach: A characteristic property of orthogonal functions.—P. J. Myrberg: Discontinuous groups of linear substitutions.—C. Dévé: An apparatus for microscopic reduction entitled "Pantographic." A description of a simplified pantograph, without articulation.—Bernard Lyot: Variations of the polarisation of Mars in the course of an

atmospheric disturbance—Jean Boccardi. The rotation of the interior planets—H. Noirel. Determinations of the intensity of gravity made in the Republic of Ecuador during the expedition of the Service géographique de l'Armée (1899-1906)—Mlle E. Gleditsch and E. Botolfsen. The X-ray spectrum of praseodymium, neodidymium, and samarium. Tables are given showing the wavelengths of seven lines for each metal—J. Heyrovsky: The physical significance of electrolytic solution pressure—Eugène Delauney. A new method of quantitative analysis by X-rays. Various elements absorb a monochromatic bundle of X-rays to different extents. Details of the application of the method to solutions of barium and strontium chlorides, and of potassium chloride and bromide, are given—J. L. Costa. The precise determination of the atomic mass of lithium 6 by Aston's method. Taking $\text{He} = 4.000$, the mass of the lithium (6) atom was found to be $6.010 \pm .002$ —René Audubert and Henri Rabaté. A method of determination of the granulometric distribution of dispersed systems—Ch. Courtot and R. Geoffroy. 2,7,9,9'-tetrahydroxyfluorene—R. Lautz and A. Wahl. The arylaminonaphthoquinones. The arylaminooxynaphthalene sulphonic acids—L. Cayeux. The existence of diatomaceous silex in the flints of the coarse limestone in the neighbourhood of Paris. The silex consists of petrified organic residues. Remains of foraminifera, radiolaria, ostracods, and gasteropods were found—J. Orcei. A white chlorite from Madagascar—Fernandez Navarro. The meteorite of Olivenza (Spain). This was seen to fall on June 19, 1924. The predominant mineral is olivine, but the meteorite is remarkable for the small proportion of nickel-iron.—Jacques de Lapparent. The two forms of hydrocarbons in bituminous schists—H. Bouygues. The axillo-cotyledon facies of the Soissons bean—Alfred Labriet and Raoul Husson. The principle of vocal accord, or a contribution to the elaboration of a theory of the normal emission of the singing voice, and the synthesis of the corresponding vocal mechanism—P. Mazé. The influence of fluorine and iodine on the reproductive functions in rats and on the growth of the young. Experiments on the necessity of the presence of fluorine in the diet of rats to ensure reproduction—T. Kahn. Active protoplasmic mass and reserve albumen—Ch. Richet, jr, and R. Monceaux. Modifications caused by cooking in the metabolism of meat. From experiments on dogs it is concluded that the metabolism of raw meat is more perfect than that of cooked meat. In diseases of the liver it is advantageous to administer raw meat. In renal affections, however, well-cooked meat is indicated—J. Benoit. Compensating hypertrophy after unilateral castration in the domestic cock—E. Fauré-Fremiet and J. Murakami. The amœbocytes of the earth worm in the quiescent and in the active state—H. Hérissé. Asperuloside, a new glucoside extracted from the wood-ruff. The new glucoside has been prepared in crystals, contains no nitrogen, and gives on hydrolysis a reducing sugar and asperuligenol—Alphonse Labbé. Four generations of *Artemia arietina*—MM. Mouriquand, Leulier, Michel, and Idrac. C-avitaminosis and cholesterinaemia—Raoul Bayeux. Structural modifications of the lung under the influence of great barometric decompressions. The essential primitive lesion of the lung determined by a sudden fall in the atmospheric pressure is the parietal hypertrophy of the alveolæ; all the cardio-vascular phenomena are secondary to this initial lesion.—F. Henrijean. The signification of the electrocardiogram.

Official Publications Received.

Falmouth Observatory. Meteorological Notes and Tables for the Year 1924. By Joshua Bath Phillips. Pp. 10. (Falmouth.)
The University of Leeds. Department of Coal Gas and Fuel Industries (with Metallurgy). Report of the Lecturer for the Session 1923-1924. Pp. 11. (Leeds.)
Mitteilungen der Naturforschenden Gesellschaft in Bern. Aus dem Jahre 1923. Pp. 122+143. Aus dem Jahre 1924. Pp. 121+156. (Bern.) K. J. Wyss Erben.
Proceedings of the Edinburgh Mathematical Society. Vol. 43 (Session 1924-25), Part 1. Edited by Dr. T. M. MacRobert and Prof. H. W. Turnbull. Pp. 11+84. (London: G. Bell and Sons, Ltd.) 5s. net.

Diary of Societies.

SATURDAY, JULY 4.

INTERNATIONAL CONGRESS OF RADIOLOGY (at Central Hall, Westminster), at 10 A.M.
BRITISH MYCOLOGICAL SOCIETY (Phytopathological Excursion to Cambridge).—Prof. Sir R. H. Biffen and F. L. Engledow. The Inheritance of Disease Resistance.—F. T. Brooks and W. O. Moore. Silver-leaf Disease.—N. J. G. Smith. Helminthosporium Diseases of Cereals.—D. Weston. The Control of Blight in Wheat.—R. C. Woodward. Apple Mildew.—Mrs. M. N. Kidd. Fungal Invasion in Apples in Relation to Senescence.—S. M. Weidman. Clover Rot.—A. Smith. Perennial Rust Mycelia.—Prof. Nuttall, Dr. Hare, and Mr. Tat. Fungi Pathogenic to Man.
PHYSICAL SOCIETY OF LONDON (at Oxford).
PHYSIOLOGICAL SOCIETY (at Oxford).

MONDAY, JULY 6.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—G. L. Purser. The Alimentary and Respiratory Systems of *Calamagrostis canadensis*, Smith.—W. J. M. Menzies. Salmon (*Salmo salar*) of the River Moine, Eastern Canada.—Dr. W. W. Taylor. Precipitation of Sols by Polyvalent Ions.—J. A. Warren and W. A. Tat. Analysis of Rainfall Records in Glandevon Catchment Area during the years 1914-1920.—Prof. A. A. Lawson. Contribution to the Life-History of *Bryonia*.—Dr. E. Neavey. Ammonites from the Upper Kimmeridge Clay.
ROYAL INSTITUTION OF GREAT BRITAIN, at 8.—General Meeting.
FARADAY SOCIETY (Annual General Meeting) (at Chemical Society), at 3.15.—At 5.30.—A. L. Marshall. The Electrodeposition of Zinc from Acid Zinc Sulphate Solutions.—F. L. Usher. The Nature of the Interfacial Layer between an Aqueous and a Non-Aqueous Phase.—J. B. O'Sullivan. The Application of the Quinhydrone Electrode to the Measurement of E_h Values in Solutions containing Copper Ions and other Divalent Ions.—J. A. V. Butler. Co-ordination and Valency.—E. P. Campbell. A Chemical Theory of Remanent Magnetism.
ARISTOTELIAN SOCIETY (at University of London Club, Gower Street), at 8.—Miss L. S. Stebbing. Logical Categories.
MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at Birmingham University).

TUESDAY, JULY 7.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at Birmingham University).—Sir Frederick Mott. Presidential Address.
INSTITUTION OF MECHANICAL ENGINEERS (Summer Meeting) (at Newcastle-upon-Tyne). (Continued on July 8, 9, 10.)

WEDNESDAY, JULY 8.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at Birmingham University).—Dr. G. A. Auden. Encephalitis Lethargica and its Psychological Implications.

THURSDAY, JULY 9.

DIESEL ENGINEERS' ASSOCIATION (at Town Hall, Maidenhead), at 3.—G. O. Milton. The Working of the Ruston Mechanical Injection Engine.
TUBERCULOSIS SOCIETY OF SCOTLAND (at 6 Drumshugh Gardens, Edinburgh), at 4.30.—Prof. H. Moellgaard and Prof. K. Faber. The Sero-cylin (gold) Treatment of Tuberculosis.
MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at Birmingham University).—Dr. Graves. Incidences of Chronic Sepsis in Mental Disease.—Dr. Pickworth. The Iodine Content of Thyroid Glands.

FRIDAY, JULY 10.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at Birmingham University).—Dr. A. M. McCutcheon. The Institutional Treatment of Mental Inefficiency.—Dr. W. A. Pott. Delinquency.—Dr. H. Smith. The Psychopathic Personality.

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SATURDAY, JULY 11, 1925.

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Science in Boys' Schools: The Administrative Aspect.¹

THE issue by the Board of Education of the pamphlet before us is opportune, having regard to the development of secondary schools now being taken in hand. The report expresses the views of five of H.M. Inspectors and deals more particularly with observations in 39 boys' schools, mostly urban. As a rule, the schools contained more than 400 pupils and had Advanced Courses; high value is rightly attributed to the institution of these courses, which have brought about improvements in apparatus and equipment—including libraries—and, best of all, secured more highly qualified teachers. Throughout the report, references appear to the primary need for securing teachers of sufficiently wide knowledge, breadth of interest, and business capacity in management of the science side of a school in all its details, financial and technical as well as professional. The science master must be competent to design and revise syllabuses, to draft requisitions, to organise the economical use and repair of apparatus. It is suggested that university training departments should teach laboratory management, the need of which is even greater among science mistresses than with men.

The whole report is evidently the result of careful, fair-minded observation, and if the constructive suggestions are too restrained, there are fairly plain hints to any science master who looks for guidance. He is urged to aim at a really good standard of equipment, and school authorities are advised to provide for the gradual carrying out of well-planned schemes extending over a few years. There is no doubt that much can be done thus, particularly with subjects like electricity and optics where the apparatus is practically permanent.

The neglect of biological studies, and the narrowness of the syllabuses, are attributed to the over-specialisation which the universities require in candidates for degrees. At Cambridge and London, mathematics, physics and chemistry suffice for the preliminary years of the degree course. Boys who are not introduced to biology before leaving school seldom take up such study later—"in this matter we are in a vicious circle." It may be pointed out, however, that some alert headmasters of the larger Public Schools are developing biological classes, securing thereby an infusion of valuable thinking into the higher forms and an avenue to open scholarships which is not at all crowded at present. More than this is needed to cure the too urbanised outlook of our boys, but perhaps there is better hope for biology introduced from above to supply the sixth form "specialist" than from the

¹ Report of an Enquiry into the Conditions affecting the Teaching of Science in Secondary Schools for Boys in England. Pp. 28. (London: H.M. Stationery Office, 1925.) 3d. net.

nature study of the preparatory school. One wonders what would have happened if biology had changed places with engineering in the growth of Oundle School.

Another weakness in the present administration is the inadequacy of the provision of laboratory attendants. This is bad economy. An example is given of a very efficient school in which the laboratories are economically run, that is, with wise expenditure and without waste. The cost of apparatus and materials is 9s. per head and of wages 7s. 6d. per head, which is about one-third of the corresponding figures for the larger public schools. It would have been worth while to point out that to leave an unskilled youth to clean up is to expose a laboratory to risk of destruction by fire.

In view of the number of new schools now being planned, it is to be hoped that the Board of Education will issue some suggestions on the planning of general and advanced laboratories for boys and girls respectively. It is extremely difficult to alter a block of science buildings, and too many laboratories are built on a wrong assumption as to the number of pupils to be taught as a class. More and more pressure to reduce the staffing ratio will come, partly as the result of Burnham scales, and the Board of Education will be compelled to face the problem of the desirable size of classes in practical work.

In connexion with the Burnham Scales, it is unfortunate that the Board of Education refuses to recognise works experience as qualifying in any way for service increments. Two examples come to mind, both of university graduates, where recognition was granted by the local education authority and refused by the Board of Education. One of these had first-rate works experience and has designed and made, with the aid of his boys, most of the really good equipment for teaching mechanics and electricity in his school. The other had experience as assistant in the Cavendish Laboratory which has been of immense help to his teaching. Both men have now to accept lower salaries than if they had become teachers without such experience. Not all works experience is valuable, but it is sheer folly to put obstacles to teaching in secondary schools in the way of such men as those to whom we have referred. It is to be hoped that the new award will leave appointing authorities some discretionary power of recognition of such experience in instrument-making as calls for the study of scientific principles and the acquisition of manipulative skill.

In their concluding observations the inspectors return to the first essential—the quality of the teacher. Quite rightly, credit is given to the Science Masters' Association and the *School Science Review* for the useful work done in promoting discussion and interchange of opinion among teachers. A science teacher and

inspector of long experience wrote recently to express his "deep indebtedness to NATURE for invaluable help during all my teaching career, especially during the years when I was almost cut off from science workers except for the holidays when the British Association brought the needed companionship of fellow-workers." Without insisting on any particular journal, it may be regarded as a bad sign if a science master is neglecting current scientific literature. The short courses arranged for vacations by the Board of Education are excellent, and they are widely appreciated. Why are half the applications refused? If the Board is unwilling to spend the money, this is another bad economy. But considering the pressure in the opposite direction, it is perhaps fairer to thank the Board for all it is doing, especially the successful attention by which the courses are made of such direct value in the school-teaching of science. We are grateful for this Report, which we hope will be studied in detail by headmasters as well as science masters, and also by the administrative side of the Board.

The Unity of Social Science.

The Earth before History: Man's Origin and the Origin of Life. By Edmond Perrier. Pp. xxiv + 345. 15s. net.

Prehistoric Man: a General Outline of Prehistory. By Jacques de Morgan. Pp. xxiii + 304. 12s. 6d. net.

Social Organisation. By Dr. W. H. R. Rivers. Edited by W. J. Perry. Pp. xi + 226. 10s. 6d. net.

Language: a Linguistic Introduction to History. By Prof. J. Vendryes. Translated by Dr. Paul Radin. Pp. xxx + 378. 16s. net.

History and Literature of Christianity from Tertullian to Boethius. By Prof. Pierre de Labriolle. Translated from the French by Herbert Wilson. Pp. xxiii + 555. 25s. net.

The Threshold of the Pacific: an Account of the Social Organisation, Magic and Religion of the People of San Cristoval in the Solomon Islands. By Dr. C. E. Fox. Pp. xvi + 379 + 14 plates. 18s. net.

The History of Civilisation Series. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, Inc., 1924-1925.)

SOCIAL and cultural scholarship, or as we call it in its beginnings, humanism, was, in the development of modern European thought, born before natural science. But it has been badly out-distanced by its younger sister, and only of late can it be seen emerging out of disorganisation and chaos. Nor is the road quite clear yet. Is there any unity in the vast medley of "histories" and "philosophies" whether of language or of literature, of art or of political institutions, of

economics or of morals, of law or of religion? In what relation do they stand to the old-fashioned history, pure and simple? Is *sociology* merely a new name for these studies taken in bulk, or does it stand for an attempt at unification in method, aim, and the adjustment of tasks?

To these questions, and to many other detailed ones, there is no answer yet on which all can be agreed, though philosophers and methodologists have been busy discussing them for some time, especially in Germany. There is, however, a marked tendency at present among the specialists as well as among those who survey matters from epistemological points of vantage to come into touch with each other, to recognise the unity of social science and to co-ordinate their work so as to avoid unnecessary duplication, to eliminate unhealthy specialism, and to foster the sole aim of humanism—the knowledge of man's nature, of his social organisation and of his culture.

The History of Civilisation Series, some volumes of which form the subject of this notice, promises to be perhaps the most important contribution so far undertaken towards the task of organisation and systematisation of the social studies. A glance at the prospectus makes us anticipate a library of masterpieces, for the best workers of France, Great Britain and some other countries are contributing from their own speciality and are attempting to bring it into line with the contributions from neighbouring fields and with the results of general sociology. Including all the volumes of the important French collection "*L'Évolution de l'humanité*," started a year or two ago and now in progress, the English Library, edited by Mr. C. K. Ogden, of Magdalene College, Cambridge, contains additions and improvements which will place it, no doubt, above its continental counterpart. The volumes already issued in English fully bear out our best hopes, and those additions which do not belong to the French series, the volumes by Dr. Rivers and Dr. Fox, establish its claim to superiority.

The whole plan of the English series is in itself a vindication of the unity of social science. Arranged so as to include all manifestations of human culture accessible to the eye of science, it follows roughly a combined historical and geographical plan. Starting from the most comprehensive picture, the empty earth in the midst of the empty universe awaiting the arrival of man, it passes then to the gradual development of organic life and the early history of mankind. These initial stages, described in the volumes of MM. Perrier and de Morgan, are accompanied by a series of introductory works which give a theoretical account of the various aspects of human culture: social organisation (by Dr. Rivers) and language (by

Prof. Vendryes), the two tools of human action and of human thought; the geographical and the racial factors (in two volumes by MM. Febvre and Pittard); an epitome of man's political evolution (in the book of MM. Morel and Davy, "*From Tribe to Empire*"); a volume on man's primeval domesticity ("*Woman's Place in Simple Societies*," by Prof. J. L. Myres), and "*Cycles in History*" by the same writer.

The story then begins at the traditional cradle of culture, the ancient East, on the holy banks of the Nile, the Euphrates and Tigris, and on the shores of the Mediterranean, where the origins and history of the early Empires and their civilisations are described. Remaining within this geographical area, we follow the lead of time, and after having been shown the growth of the *Ægean* civilisation and the formation of the Greek people, we study the history of Greece in all its wonderful cultural achievements; next, in obedience to historical destinies, hegemony has to be surrendered to Rome, with the laws, politics and economic organisation of which we are then concerned, from the humble republican beginnings to the final expansion of the Empire. This brings us far beyond the geographical boundaries of the Mediterranean basin to the vast areas occupied by the Teutonic peoples to the north, the Persian, Indian and Chinese civilisation to the east, and the Mongol cultures of Central Asia. All these cultures will be studied in a series of monographs in a special section which closes the big division devoted to pre-history and antiquity. The second division will contain volumes on Christian religion, on the break-up of the Roman Empire, on the religious imperialisms of Christianity and Islam, on the political, social, economic and intellectual evolution in the Middle Ages and modern times. The English library contains besides all this several special sections, one on the histories of various subjects, such as medicine, money, costume, witchcraft and what-not; a section on Oriental culture, on historical ethnology, and a few more special sections not yet exhaustively announced, dealing with modern history.

The field of social science is thus fully and comprehensively covered in the English library. But this summary following merely geographical and chronological lines does not do full justice to the merits of the plan and of the achievements of the series, so far as they have been laid before us. It is the nature of the subjects treated in each group which constitutes its importance and makes it absolutely unique, as the first fully scientific history of civilisation in the English language. For there is no doubt that a deep modification in our conception of history has taken place during the last generation or so.

Take, for example, the history of Greece or Rome.

For most of us it has been, and still remains, the kernel of historical reality and the standard of our cultural values. Ancient Greece especially embodies for us the retrospective ideal of heroism, beauty and wisdom shining in the glory of a unique setting, of a chosen people and of an irrevocable past. We have our Golden Age in this myth of Greek culture, of Roman statesmanship, and this myth has been one of the main civilising forces from the Renaissance up to the present day. However science might deal with this mythology, scholars, dreamers and metaphysicians will still read into certain epochs of history an inspiring epic, a thrilling drama, a revelation of purpose and wisdom in destiny, a moral inspiration which allows man to bear the gloom and oppression of his own time. The reality of Homeric fights, of the Biblical stories and the myth of classical antiquity, will remain untouched for ever by the most destructive of "higher criticisms."

This is well, for we want our myth to remain intact, while at the same time the spirit of science forces history into accomplishing a different task from that of glorifying and idealising the past or of making it into a dramatic play of national destinies. The new history cannot carry out its work without the help of social science, psychology and a comparative study of culture. Scientific history, after it has thrown overboard drama, sentiment and myth, after it has introduced the most rigorous methods of scrutinising and reconstructing sources, still stands helpless before its main task: and that is to build up the process of human development in terms of personality and character as they work upon masses of people and as they solve questions of organisation and politics, of taxation and other economic arrangements, of warfare and education, of domestic, moral and religious institutions. For the knowledge of personality and character the historian might repair to the psychologist; in the study of organisation and politics the sociologist might help him; the scrutiny of values, whether material or moral, has to be carried on in collaboration with economics, the science of material culture, ethics and other normative disciplines.

Yet in all this the historian will find that he has quite as much to give as to take, for each of his auxiliary sciences has suffered by conducting its work single-handed and upon a somewhat artificially specialised material. The student of psychology has worked on an isolated, individual mind, suspended *in vacuo*, and he has wasted much of his time therefore in studying an unreal figment. Endless "sociologies" have been written upon a subject constructed *ad hoc*, whether it be the "group mind" or the "consciousness of kind," "imitation" or "race war" conceived as unique sociological principles, the "purely formal" in human organisation or the "exclusively organic." Economists

have created another figment for science in the mathematically economic man who follows the purely economic motive. The moralist made his "absolute good," his "categorical imperative" or his "moral sense," and proceeded forthwith to study and to worship the idol fashioned by his own hands. Each specialist foredoomed his results by working on a figment. For human nature cannot be cut up into bits, nor man's mental endowment separated from his social habits or his material culture, or his moral and economic values. The human mind, with its plastic instincts shaped into cultural habits, its reason bound up with language and its emotional life determined by social bonds, values and ideals, is an integral subject of study. Specialisation there must be, and it probably will have to run on the traditional lines of psychology, sociology, economics, ethics and so on. But this specialisation must be the result of a central theory of human culture, this term of course embracing the human mind, the factors of organisation and material civilisation.

In this the historian, coming with his concrete, full-blooded reality of an individual civilisation at a definite epoch evolved by a definite race, forces the specialists to face the real problem. For in the concrete reality of life, regarded comprehensively and examined scientifically, we see how all the aspects intermingle and influence one another,—each sufficiently independent to require a specialised study, each at the same time so deeply influenced by the others that it must be studied against the background of the whole culture.

We can see this method well exemplified in the scheme of the Greek section in this library. The ethnographic foundation of Greek culture is given in the first volume on the formation of the Greek people. Economics, religion, art, science, politics are then studied in separate contributions, each written in a sociological spirit, each giving an analysis of one aspect of Greek culture, yet all connected into one comprehensive picture. The analysis of any other part of the scheme shows the same plan, and the names of the writers vouch for the fact that every contribution will be written in the modern scientific, that is, sociological spirit.

It is in this that the English series shows its superiority over the French library. In glancing over the prospectus of this latter, one or two capital omissions at once strike us forcibly. A series conceived in the sociological spirit should place perhaps two subjects in the forefront of its attention: economics and the study of domestic life. The importance of the former has been underestimated for ages by the historian, though it has certainly been over-emphasised in the modern theories of historical materialism. Nevertheless, childish as it is to regard wealth as the unique *vera causa* of all cultural process, its study cannot be omitted from any

scientific account of any type of civilisation. Even modern anthropology has begun to discover in theory and in field-work that the production and acquisition of material goods play a far greater part in primitive life than was ever suspected by the earlier authorities. In historical times, economics play an important part in the shaping of political history, of social organisation and of the other cultural pursuits, but certainly not as a unique and sufficient cause of everything, but as an element with which man cannot dispense, and which in consequence the student must not ignore.

The other factor, domesticity and family life, is, so to speak, the crucial test of really scientific anthropology and history. The most ubiquitous elements in man's life—the school of his infancy, the background of his youth and the aim of his age—the family and the household, are certainly the cell of human society, and their constitution influences deeply the other forms of social grouping in any culture. Modern psychology teaches us also that the early influences of the family leave a deep impression on the individual's mind and in consequence upon the whole cultural activity of a community. There is no doubt, however, that the scientific treatment of domesticity in its influence upon culture is extremely difficult. Just because it is so deep and powerful an influence, it is to some extent intangible and invisible; so that the modern historian finds in his sources only scanty and indirect information about the domestic life of the average individual, although archæology, folk-lore and even comparative anthropology can assist him in this to a great extent.

It is therefore a remarkable omission that in the French series the two subjects of economics and domestic life should have been almost completely neglected. This gap will be filled by Mr. Ogden in the English library, and he has summoned to this task the help of competent writers. The volume by Prof. J. L. Myres on "Woman's Place in Simple Societies," which is announced; the works on "Life and Labour in Greece and Rome," by M. Glotz and M. Paul Louis; the contribution on the regime of the castes in Ancient India, by Mr. G. S. Ghurye; the book on popular life in the last Roman Empire by Prof. N. Baynes; the volumes on "Life and Labour in the Middle Ages and in Modern Europe," by M. Boissonade and Prof. Renard, and on "Women in Medieval Times," by Dr. Eileen Power; the "Philosophy of Capitalism" and the "History of Money," both by Dr. T. E. Gregory—all these, confined to the English series—promise by their subjects to be among the most interesting volumes, and by their authors, among those of the greatest value in the library.

The comparison between the French and English series and the advantage derived from the combination

of the best forces in two countries suggest the one serious criticism that could be made with regard to the present enterprise—the almost complete lack of German and American contributions. German scholarship in works referring to classical antiquity, in comparative linguistics, in many domains of psychology, in historical economics, jurisprudence and in the theory of the state is unrivalled. No one will suspect Mr. Ogden, the War-time editor of the *Cambridge Magazine*, of narrow-minded chauvinism or of any of the futile though unfortunately widespread prejudice against the science of a great nation. It is therefore to be hoped that in the pending additions to the series announced in the prospectus there will be included the works of some of the leading humanists of Germany.

It is also to be hoped that some of the best works of the United States to be published within the next few years will find their way into this series and make it even more representative and international. For in this big collective work on civilisation the unity of human culture and of human science should be manifested by the co-operation of different nations as well as in the intrinsic unity of the subject with which the authors are dealing.

B. MALINOWSKI.

Real Builders of America.

A Popular History of American Invention. Edited by Waldemar Kaempffert. Vol. 1: Transportation, Communication, and Power. Pp. xvi+577. Vol. 2: Material Resources and Labor-Saving Machines. Pp. xiv+457. (New York and London: Charles Scribner's Sons, 1924.) 63s. net.

TO the extraordinary development of the United States during the last century, history presents no parallel. From a position of comparative insignificance she has risen to be the greatest manufacturing nation the world has ever seen. The growth of her industries has indeed been remarkable, and the real builders of her fortunes have not been her statesmen and soldiers, but her mechanics and inventors. While, however, the story of her national progress is fairly familiar, a knowledge of her pioneers and their work is not general, and it was therefore a happy thought to bring together this series of essays giving a review of the great things achieved.

It was to an American audience that Lord Playfair once remarked, "Science has no country though its investigators have birthplaces." In some degree the same may be said of invention, and frequently the plan of writing the history of either science or invention from the national point of view is unsatisfactory. Still, there are advantages if the work is done impartially, and fortunately the editor and writers of this popular

history of American invention have not been too eager to emphasise the work of their countrymen at the expense of others, and the sketches, though by many writers, are throughout eminently readable, entertaining, and informing. The work is well balanced; good accounts are given of scientific discoveries and mechanical inventions made in Europe before being taken up in the United States, and a large proportion of the illustrations are from the Science Museum, South Kensington, the Deutsches Museum of Munich, and other institutions. We thus read the old stories of Watt and Stephenson, Volta and Faraday, Gutenberg, and Daguerre, and Daimler, in a new setting.

There are in all 27 chapters by 18 different writers, and the work is divided into five main parts devoted to transportation, communication, power, material resources, and labour-saving machines. The opening chapter deals with railways, and in the year which is seeing the celebration of the centenary of the Stockton and Darlington Railway this is of especial interest. American locomotives have long ago surpassed European engines in size and power, though not in speed and efficiency, and we are told that the largest goods engine, the Virginian, weighs 450 tons, and has no less than 10,725 square feet of heating surface in her boiler. The *Rocket* had 137 square feet. Several of the chapters give striking statistics; and in the first chapter it is stated that the United States now has 69,000 locomotives, 57,000 passenger cars, and 2,500,000 freight cars. The railways employ about 2,000,000 men.

After the story of the railways come those of the steam-boat, electric traction, motor cars and aeroplanes. The next group of chapters is devoted to printing, type-writing—in 1919 the world produced 875,000 typewriters, of which 775,000 were American—telegraphs, telephones, wireless, photography, "Pictures that Live and Move," and phonographs. Though the moving picture business owes its main development to American enterprise, a fair account is given of the work of Faraday, Plateau, Horner, Marey, and others, but the birthplace of the "movies" was Philadelphia, where at the Academy of Music in February 1870 Henry Heyl threw on the screen a series of pictures showing the movements of a couple waltzing. The reader is taken behind the scenes of a studio, and it will perhaps come as news to many to read that some of the accidents seen on the films are real ones, and that Hubert Kittles, a well-known motorist, "was in bed for weeks with broken bones after a realistic motor cycle race, in which the story called for a real tumble."

The second volume of the history treats of the great metallurgical, oil, timber, machine tool, and textile industries. We see how the inventions of Bessemer and Siemens led to the rise of Pittsburg, how petroleum

wells are sunk, how giant forest trees are felled and transported, how the agriculture tractor came into being, and how boots are made by machinery, enabling the States to turn out 300,000,000 pairs of shoes a year. Machine tools had their birth in the shops of Wilkinson, Bramah, and Maudslay, but to-day they are designed by the staffs of professional inventors maintained by the great companies. They are characteristically American in the sense that they have been brought into being to solve the problem of producing vast quantities of metal articles cheaply in the face of high labour costs.

In the space of 1000 pages it was, of course, impossible for the writers to deal with all the pioneers. We thus miss any mention of James Rumsey and his steam-boat, of Ericsson and his gun turret, of the work of the great iron master John Fritz, and of Robert M'Alpine, the father of the wood pulp industry. In the chapter on the incandescent lamp, Swan should certainly have been referred to. But apart from these and other minor criticisms, it must be conceded that this popular history is one of the best books of its kind which have yet appeared.

Bird Life on the Norfolk Broads.

Broadland Birds. By E. L. Turner. Pp. xvi + 172 + 51 plates. (London: *Country Life*, Ltd., 1924.) 15s. net.

THAT skilful watcher and photographer of birds, Miss E. L. Turner, has published what she describes as "just a record of my own personal observations of the birds I have lived with for twenty years." She has had opportunities which many will envy, and has used them in a way which all must admire. She has spent the whole of many seasons in a house-boat on Hickling Broad, devoting herself entirely to the observation of bird-life in that interesting locality. By dint of much patient watching, she has acquired a great knowledge of the intimate lives of some of the most interesting and least accessible species. What she has learnt she faithfully records as a plain narrative, avoiding anthropomorphic interpretation on one hand and not attempting theoretical deduction on the other. The result will give much pleasure to lovers of birds, and at the same time is of considerable scientific interest.

Several noteworthy ornithological events are recorded in these pages, such as the first nesting of the bittern, in 1911, after it had been for long regarded as extinct as a British breeding bird, and the nesting of the ruff in 1907 after an interval of many years. The bittern, happily, is now re-established, but so far the ruff has not been found to nest regularly. Miss Turner also describes the first nesting of the cormorant in

East Anglia for a century—on a high tree, as is commonly the case inland in Ireland and on the Continent.

Other chapters in the book deal with birds which range from comparatively uncommon species, such as the stone-curlew and the bearded tit, to familiar birds which may be found in marshlands throughout the country. About all of them we are told something of interest, but we are at the same time warned against hasty generalisation from the behaviour of a few individuals, because close observation reveals great differences in behaviour between one and another of the same species.

The writer has not always restricted her stay in Norfolk to the nesting season, but has also spent the autumn and winter in her house-boat. In late summer she has seen migrating swifts arriving from the north-east, appearing first at dawn as a faint cloud in the zenith which rapidly drops earthwards and resolves itself into a great host of birds. In autumn she has seen the vast concourse of millions of starlings which roost in the reed-beds and perform aerial evolutions on such a scale that the line may "stretch from Potter Heigham Church on the south to Hickling Hill on the north-west, a distance of five miles." In mid-winter, with the broads nearly ice-bound, she has seen such things as fifty-four swans, in strict chevron formation, passing across the face of the moon.

Miss Turner apparently began as a bird photographer, but she has become much more than that. Her book would indeed have been well worth reading, as a record of observations, even without the excellent photographs with which it is illustrated, although naturally they add much to its charm. Many of them are of value in depicting action instead of being portraits only.

Our Bookshelf.

La Géochimie. Par Prof. W. Vernadsky. (Nouvelle Collection scientifique.) Pp. vi + 404. (Paris: Félix Alcan, 1924.) 12 francs.

THIS book of four chapters is a reprint, with some amplification, of lectures given by Prof. Vernadsky at the Sorbonne during 1922-23. The first chapter, which opens with the questionable statement that geochemistry is a science new to the twentieth century, is devoted to general considerations, including the subdivision of the earth's outer layers or envelopes according to their physical, chemical and biological characteristics. Apart from the atmospheric layers, Vernadsky's various groupings of these envelopes may be indicated roughly as follows:

Superficial	{ Water and superficial crust }	Biosphere.
Metamorphic	{ Sedimentary and granitic }	Lithosphere.
Magmatic	{ Basaltic }	Magmosphere.

Minerals stable in the superficial envelope are termed *vadose*, those in the metamorphic envelope *phreatic*, and those in the magmatic envelope *juvenile*. Cycles of change in the chemical composition of minerals are distinguished as *primary cycles* if their completion is effected in two or more envelopes, and *secondary cycles* if they are completed within the limits of a single envelope. The application of these notions is illustrated by a detailed account of the geochemical history of manganese, which furnishes an example of a primary cycle involving juvenile, phreatic and vadose changes. Chap. ii. deals with silica and the silicates, Chap. iii. with carbon and living matter, and Chap. iv. with the radioactive elements.

A notable feature of the book is the large place allotted by the author to biochemical agencies in mineral transformations. His account of the dynamic equilibrium between carbon dioxide and living matter, or what he calls the *vital cycle*, is of special interest from a ~~view~~ view. His discussion of biochemical evidence, however, shows that he is an enthusiastic supporter rather than a critical examiner of the claims made for biochemical factors in geochemical changes. An example of this is provided by his reference to the process of laterisation, and his easy conviction that the process is clearly a biochemical one.

In a general way, Prof. Vernadsky's views are less likely to be challenged by chemists and physicists than by geologists; but it will be admitted by all that his book is full of interest on account of its largeness of outlook and its ample recognition of the many-sided character of geochemical problems. T. C.

Physics in Industry: Lectures delivered before the Institute of Physics. Vol. 2. By Dr. J. W. Mellor, Dr. A. E. Oxley, Prof. C. H. Desch. Pp. 48+6 plates. (London: Oxford University Press, 1924) 3s. net.

THE appearance of a second volume of these valuable lectures on physics in industry evokes the thought—and the fear—that before long we may have a special society and a special journal devoted to this subject. But for the fact that engineering has hitherto been regarded as the one and only field of applied physics that matters, these would probably have seen the light many years ago. Industrial chemistry has long been in the public eye; industrial physics, apart from engineering, has yet to come into its own.

In his absorbing lecture on the applications of physics to the ceramic industries, Dr. Mellor was compelled by the tyranny of time to confine his remarks to applications that are not common to other industries, such as the drying of clay and clay wares, thermal and contraction strains in ceramic goods, and the electrical and thermal expansion of glazes. He deals lucidly and suggestively with these topics, and his general remarks on applied physics and physicists, if not entirely novel, are very sound. Dr. Oxley, as physicist to the British Cotton Research Association, has found, contrary to expectation, a vast field for research in the textile industries, and particularly in bringing scientific method into the testing-room. He points out that the distinguishing feature of physical research in this field is that, owing to great variability in the raw materials, series of observations sometimes involving many

thousands of readings have to be made, and conclusions drawn from them by statistical methods. As examples of the work to be done he discusses the testing of rigidity, elasticity under strains, effects of variable stresses, fatigue, regularity of the spun thread, and the appearance of the finished fabric. He concludes with the recommendation that abstracts on the progress of textile research should be given their place in the chief scientific journals. The third lecture, on the physicist in metallurgy, shows the enormous importance of physics in later-day metallurgical research and practice. The most numerous and varied applications of physics, states Prof. Desch, are connected with the heating, forging, hardening, and alloying of metals. Magnetism, he tells us, is becoming of increasing importance, and atomic structure, properties of crystals and X-ray analysis, are all of actual and potential value in metallurgical research. The lectures reach a high standard, and the introductory remarks by the Hon. Sir Charles Parsons concerning the rôle of higher mathematics in applied physical research should not be overlooked.

Arabische Alchemisten. Von Julius Ruska. 2: Ġa'far al-Šādiq, der sechste Imām. Mit einer Nachbildung der Handschrift Gotha A. 1292 (Haleb 338) in Manuldruck. (Heidelberger akten der Von-Portheim-Stiftung, Heft 10.) Pp. 128+62. (Heidelberg: Carl Winter's Universitätsbuchhandlung, 1924.) 7·20 gold marks.

PROF. RUSKA'S erudition is equalled only by his energy. He has now followed up his monograph on Chālid ibn Jazīd (see NATURE, September 20, 1924, p. 427) with an interesting and important memoir on Ġa'far al-Šādiq, the sixth Imām. Included in the memoir are the text and a translation (with full notes) of an alchemical treatise falsely attributed to Ġa'far, the "Book of the Letter of Ġa'far al-Šādiq on the Knowledge of the Art and of the Noble Stone." The text is a facsimile of MS. A. 1292 at Gotha, and is supplemented by additions and variations from a manuscript in the Library at Rampur.

The memoir is divided into six sections: (i.) Ġa'far al-Šādiq in history and legend; (ii.) the writings attributed to Ġa'far; (iii.) Ġa'far as the teacher of Jābir ibn Ḥayyān; (iv.) Ġa'far as the author of chemical works; (v. and vi.) translation and text of the alchemical treatise mentioned above. Prof. Ruska's main conclusions are that Ġa'far had nothing whatever to do with alchemy, that all the alchemical works attributed to him are spurious, and that he could not have been the master of the great Jābir. He says that it is quite unthinkable (*völlig undenkbar*) that Ġa'far al-Šādiq could, at Medina, have come into any contact with either practical or theoretical alchemy. If this conclusion is justified, it follows that Jābir could not have learnt alchemy from him, and Prof. Ruska is therefore forced to the extremely important conclusion that "all writings ascribed to Jābir, in which Ġa'far al-Šādiq is represented as his master and teacher, are to be regarded as falsifications of a later date."

Prof. Ruska's conclusions are certain to have the happy result of provoking much further research, but we feel that it is as yet too early to give unqualified assent to his criterion for judging the authenticity

of works ascribed to Jābir. His memoir is undoubtedly the most important contribution to our knowledge of early Islamic chemistry which has been made in the present century. E. J. H.

Statics: including Hydrostatics and the Elements of the Theory of Elasticity. By Dr. Horace Lamb. Second edition. Pp. xii+357. (Cambridge: At the University Press, 1924.) 12s. 6d. net.

PROF. LAMB'S books on the various branches of mechanics require no introduction to the modern teacher and student of applied mathematics. By their fluency of diction, their easy mathematical style and their lucid presentation of the subject, they have displaced most of the old-established works. The interest in the announcement of a new edition lies consequently rather in what modifications the author could possibly make to improve an already excellent work.

This second edition of "Statics" differs from the earlier edition merely in the portion dealing with elastic problems. There has been made, to the chapter on the extension of bars, a valuable addition on the treatment of redundancies. Castigliano's theorem of least energy is developed, with Southwell's simple and elegant proof. The chapter on the flexure and torsion of bars now covers the case of curved bars and the collapse of a ring under pressure, while the final chapter on stresses in cylindrical and spherical shells now includes the case of rotating cylindrical shafts.

These additions are consistent with the general tendency of all the author's work, to combine with clear and lucid mathematics a close association with the realities of the subject. This new edition merely emphasises the debt which all teachers owe to Prof. Lamb's inspiration.

Valenzkräfte und Röntgenspektren: zwei Aufsätze über das Elektronengebäude des Atoms. Von Prof. Dr. W. Kossel. Zweite, vermehrte Auflage. Pp. iv+89. (Berlin: Julius Springer, 1924.) 3·60 gold marks.

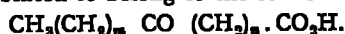
VALENCY and X-ray spectra may appear to have little in common, but valency is essentially connected with the number and distribution of the outer electrons of the atom, while X-ray spectra provide the most powerful weapon for the investigation of those which are more tightly bound; together, therefore, these two essays involve the whole question of electron distribution. The first section contains an interesting account of the various theories of valency, and considerable space is devoted to the bearing of the crystal lattice on the problem. This new edition has been slightly enlarged, notably by the inclusion of a brief account of the Lewis-Langmuir theory. Bohr's work on the periodic table is not discussed here, since the author has decided, rightly perhaps, that it could be treated more adequately in the second essay. Here Dr. Kossel has succeeded in giving, in small compass, an admirable account of X-ray spectra and their bearing on atomic structure. He emphasises the fact that an investigation of the energy levels indicated by these spectra leads to conclusions similar to those deduced from valency considerations. The first edition was deservedly popular, and no doubt this second edition will meet with equal success, giving, as it does, a clear yet concise account of these phenomena.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

X-ray Crystal Analysis as an Auxiliary in Organic Chemical Research.

At the suggestion of Prof. W. L. Bragg, I recently sent to Dr. G. Shearer, of the Davy Faraday Research Laboratory, a series of four keto-acids which had been synthesised by my wife. Dr. Shearer was not aware of the identity of the substances, which were, however, stated to belong to the series



Actually (A) was $\text{CH}_3(\text{CH}_2)_{11} \cdot \text{CO}(\text{CH}_2)_8 \cdot \text{CO}_2\text{H}$,
 (B) was $\text{CH}_3(\text{CH}_2)_{11} \cdot \text{CO}(\text{CH}_2)_4 \cdot \text{CO}_2\text{H}$,
 (C) was $\text{CH}_3(\text{CH}_2)_7 \cdot \text{CO}(\text{CH}_2)_8 \cdot \text{CO}_2\text{H}$,
 and (D) was $\text{CH}_3(\text{CH}_2)_8 \cdot \text{CO}(\text{CH}_2)_8 \cdot \text{CO}_2\text{H}$.

No case so complex had been tried in the aliphatic series previously, and yet, from the X-ray examination of a minute amount of these compounds, Dr. Shearer was able to deduce that (A), (B), (C), and (D) have chains containing 22, 18, 16, and 19 carbon atoms respectively. Furthermore, it was possible to assign positions to the carbonyl groups in (A), (B), (C), and (D) from a consideration of the distribution of intensity among the various orders of reflection from the principal planes, and it was found that the carbonyl group is 0.52, 0.67, 0.55, and 0.50 respectively, of the whole length of the molecule from the end terminating in a methyl group. The corresponding theoretical values are 0.54, 0.65, 0.50, and 0.48, which means a maximum error of one carbon atom in placing the oxygen.

The outcome, considering the difficulties, is remarkable, and this is surely the most noteworthy invasion which the physicist has yet made of the domain of the purely structural organic chemist. The specimen (B), for example, is identical with an acid found by Bougault and Charaux (1911) in various species of *Lactarius*, and therefore called *lactarinic acid*. Its relation to stearic acid was quickly realised, but a determination of the situation of the carbonyl group involved a longer investigation. Should such a case arise again, we can replace the analytical research by an X-ray examination and confirm the conclusions by direct synthesis.

In view of the importance of the normal-chain unsaturated acids in biochemistry and their ready conversion into crystalline oxygenated derivatives, there can be little doubt that Dr. Shearer's work will find many applications even in this restricted field. On a broad view the possibilities are limitless, and gradually more and more groups of carbon compounds will become amenable to this kind of direct examination. Our more difficult problems, such as that presented by the determination of the molecular structure of strychnine, cannot be completely solved by X-ray analysis at the present time, yet, even here, Sir William Bragg has recently made a suggestion in regard to a possible utilisation of the method. It is to stain the molecule with heavy halogen atoms and locate these, at least in the crystal.

A different kind of use for the X-ray spectrograph in organic chemistry is illustrated by a further incident. Mrs. Robinson has synthesised the two keto-stearic acids, $\text{CH}_3(\text{CH}_2)_7 \cdot \text{CO}(\text{CH}_2)_8 \cdot \text{CO}_2\text{H}$ and $\text{CH}_3(\text{CH}_2)_8 \cdot \text{CO} \cdot (\text{CH}_2)_7 \cdot \text{CO}_2\text{H}$, which are the possible

products of hydration of stearolic acid, $\text{CH}_3(\text{CH}_2)_7 \cdot \text{C} \equiv \text{C} \cdot (\text{CH}_2)_7 \cdot \text{CO}_2\text{H}$. It is stated in the literature that the addition of the elements of water to stearolic acid gives only the first-mentioned keto-stearic acid, but both synthetical acids melt at a higher temperature than does the substance derived from stearolic acid. Possibly the latter is a mixture of the two, and in order to confirm this view we had recourse to Dr. Shearer. He found that the principal spacings in the three specimens were identical, but that the intensity distributions among the different orders of reflection from the principal planes showed marked differences in the case of the two homogeneous acids, whilst the intensity distributions were intermediate in the case of the acid derived from stearolic acid. It is almost certain, therefore, that the acetylenic linkage of stearolic acid is hydrated in each of the theoretically possible directions when the substance is treated successively with sulphuric acid and water.

R. ROBINSON.

The University, Manchester.

The Structure of Stearic and Stearolic Acid.

CRYSTALS of fatty acids and similar long chain compounds are difficult to obtain in sizes large enough to give good "single crystal" X-ray photographs. Mr. W. B. Saville has succeeded in growing fairly large and thick crystals of stearic acid. They were obtained from a saturated solution of stearic acid in carbon bisulphide.

X-ray analysis shows that stearic acid crystals obtained under these conditions are monoclinic. The size of the unit cell is found to be $a = 5.60$, $b = 7.38$, $c = 50.9$ Å.U., and $\beta = 59.7^\circ$. The choice of the unit cell is to a certain extent arbitrary, these data give the lowest indices to the strongest reflecting planes. The density is slightly more than 1.05, thus gives four molecules to the unit cell. Previous work on series of similar compounds led to the conclusion that the carbon atoms are arranged in long and uniform chains. The c axis in the present case has been put in a plane of highest density. The chain which coincides nearest with the c axis is found to be of the tetrahedral type if the diameter of the carbon atom is taken over from the diamond structure.

A single crystal of stearolic acid investigated by means of X-rays gave different photograms from those obtained from stearic acid. The symmetry is lower, and all the data seem to indicate that these crystals are triclinic. Stearolic acid has the same number of carbon atoms as stearic acid (18), but it has a triple bond in the middle of the chain.

ALEX. MULLER.

Davy Faraday Laboratory,
 Royal Institution,
 July 1.

Solar Activity and Atmospheric Electricity.

IN view of the footnote to Dr. Chree's article in NATURE of June 27, and an explanatory note received from him recently that his article was in type before he saw my article in the March issue of the journal *Terrestrial Magnetism*, it would scarcely be fair to him to make any comments. However, I shall be glad to send a reprint of my article to any one interested in becoming acquainted with all the points involved. Furthermore, since my March article, we have found Dr. Chree's recommendation made at the Madrid meeting of the Geophysical Union impracticable. Meteorologists have likewise not adopted his recommendation for their purposes.

a perpetual calendar, and he need not have notched his tree.

It is said that there is nothing new under the sun, but this appears to me to be an original invention and a brilliant one.

F HOPE-JONES.

(Chairman, British Horological Institute.)

The Synchronome Co., Ltd.,
32 and 34 Clerkenwell Road,
London, E.C. 1

The Amani Research Institute.

MAY I be allowed to add to the timely and sympathetic article on the Amani Research Institute in NATURE of June 20, p. 933, some notes on a point not emphasised by you, namely, the possibilities of Cinchona cultivation at Amani?

From the outbreak of war in 1914 Amani was used as a refuge camp for women and children, and, until its occupation by the British in 1916, its resources, thanks to the abilities of the German scientific staff, were ruthlessly exploited for the benefit of the German armies in the field. Thus, of the "economic products," catalogued under 67 heads, manufactured at the Institute, may be mentioned 830 kgm. of "plant butter" from the seeds of *Allanblackia stuhlmannii*, 15,000 bottles of "Amani whisky" (a fearsome liquor) and medicinal alcohol, and about 400 bottles of castor oil. But most important of all were 136 kgm. of quinine sulphate, extracted at Amani, and 4000 kgm. of Cinchona bark sent to be worked up at the veterinary station at Mpagua. Prof. A. Zimmermann, the German Director of Amani, came to East Africa from Java, and brought with him both seeds of Cinchona and a knowledge of its cultivation and the quinine plantations in the event proved one of the best investments the German Government ever made. They certainly helped materially to keep the German troops in the field. Of the three varieties of Cinchona grown in the Institute grounds—*C. Ledgeriana*, *C. succirubra*, and a hybrid (Java seed) between these two—the last assayed so well and earned so remarkable a report from the Imperial Institute that it is deserving of a wide publicity. Full details can be found in the Bulletin of the Imperial Institute, vol. 16, No. 3: I need only extract the analysis of the bark:

No. 4. *C. Ledgeriana* × *C. succirubra*.

	Per cent
Moisture	7.50
Total alkaloid	11.30
Quinine	8.41
Cinchonidine	nil
Yield of crystallised quinine sulphate	11.21

and the manufacturer's opinion.

"The manufacturers stated that sample No. 4, the hybrid from *C. Ledgeriana* × *C. succirubra*, is one of the highest quinine-yielding barks they have examined, being fully equal to the finest Ledger bark from Java."

So far as experience has gone, Cinchona flourishes in East Africa only in the East Usambara Mountains, where the atmosphere is moist and the temperature remarkably low for the elevation (under 4000 ft). Certainly I have not heard of its doing really well elsewhere in Tanganyika Territory, or in Kenya Colony. But in the neighbourhood of Amani there are thousands of acres of virgin forest land which appear to be suitable for Cinchona. My instructions, in view of the report on the hybrid, were to devote special attention to quinine cultivation, and when I left Amani at the end of 1923 we had some promising plantations of *Ledgeriana* and the hybrid (Amani

seed) coming on, and, thanks to Prof. Greenish and the Director of the Wellcome Bureau of Scientific Research, some assays of the bark of known, mature hybrid trees, which confirmed the original analysis and promised to open up a tempting field of research. It had always been my hope that eventually Amani would do for the East African Colonies what Sir David Prain had done for India, and supply most of the quinine needed locally, particularly for native consumption.

ALLEYNE LEECHMAN
(Lately Director, Amani
Research Institute)

The Bedford Natural History and
Archæological Society,
Harpur Street, Bedford.

Spectroscopic Evidence of *J*-Transformation of X-rays.

IN our letter to NATURE of April 25 on spectroscopic evidence of *J*-transformation of X-rays, we pointed out that there are alternative conclusions regarding the experimental results which were taken from the Table V. given by Prof. Siegbahn in "Über die Röntgenspektren der chemischen Elemente," Jahrbuch der Radioaktivität, 1916. These conclusions are either the wave-length determinations quoted are inaccurate to the extent of more than 1 per cent, or the discontinuities which occur in $K\alpha_1$, $K\alpha_2$, $K\beta$ are real and are due to *J*-transformation of X-rays. Prof. Siegbahn gives as his judgment that the irregularities are due to experimental error: we accept this.

The values given in the Jahrbuch are evidently those of Malmer—according to Prof. Siegbahn "not very concordant measurements" (NATURE, July 4, p. 11). At the same time Prof. Siegbahn states that Malmer's "measurements give no evidence of such a sudden change in the slope of the curve as shown in the letter of Messrs. Khastgir and Watson." We should like to point out, however, that the irregularities referred to by us have been noticed independently by J. M. Cork (Phys. Rev., Feb. 1925, p. 197). Further, Gunther, so late as 1924, has quoted these same values in a booklet of X-ray spectroscopic measurements, and we employed them because they constituted at that time the only available complete set of wave-lengths throughout the region where the *J*-phenomenon appears.

Mr. Nipper (NATURE, July 4, p. 12) is evidently not acquainted with the facts concerning the *J*-phenomenon (see Phil. Mag., May 1925), otherwise he would not have advanced as evidence against our main contention the fact that Siegbahn's later—or for that matter, any other spectroscopist's—values do not show a discontinuity (increase in λ as Z is increased from 51 to 52). It was explicitly stated in our letter, and it has been emphasised by Barkla on many occasions, that wave-length is not the only factor which determines whether or not *J*-transformation of X-rays takes place in transmission through matter. Certain critical conditions are necessary: the character of the whole of the radiation transmitted appears to exercise a very important controlling influence (see NATURE, June 20, 1925, p. 942). The *J*-transformation evidently did not occur in the case of Siegbahn's recent determinations of wave-length, and we therefore obtain from them no evidence of the *J*-phenomenon.

S. R. KHASTGIR.
W. H. WATSON.

Physical Laboratory,
University of Edinburgh,
June 19.

The Cresswell Engravings.

MR. J. WILFRID JACKSON, in his letter to NATURE of June 6, p. 874, refers to the occasion when he first saw these engravings and says, "I also told him it was a mistake to outline the figures in Chinese white." I am quite sure Mr. Jackson did not intend it to be so, but, none the less, this is a misleading statement and open to a wrong interpretation. The engravings were not outlined in white, and only one specimen, the reindeer piece, has ever been so outlined. This example is executed in very fine, thin, lines upon bone afterwards scorched black by fire, hence the drawing is not readily seen unless the bone is held at the correct angle. For photographic purposes Chinese white was rubbed into the lines, as a satisfactory picture could not be obtained otherwise.

Sir William Boyd Dawkins asked me to send the engravings to him for inspection, and photographs were sent with them. As an act of courtesy, the reindeer piece was forwarded in the condition in which photographed, and my covering letter expressly pointed out that it was sent thus outlined to assist him in his examination and that the outlining could be removed immediately by the application of a sponge or damp handkerchief. As neither he nor Mr. Jackson took the trouble to do this, they are scarcely in a position to express a trustworthy opinion upon the character of the lines composing the figure. Had they done so, they would have seen at once that the lines are clean, sharp, continuous cuts, and bear no resemblance whatever to the half-tunnels formed by roots. Mr. Jackson's interpretation of certain selected markings upon an ancient skull are interesting, but no one familiar with the technique of Palaeolithic art could mistake these broken lines upon the portion he illustrates for the handiwork of man.

The authenticity of the engravings from Mother Grundy's Parlour, Cresswell, is testified by the authorities at the British Museum, by Mr. Miles C. Burkitt of Cambridge, the foremost British authority on Palaeolithic art, Prof. Sollas, and others. The considered opinion (with full knowledge of Mr. Jackson's objection) of M. L'Abbé Breuil relative to the specimens was reported in NATURE of May 2, p. 658.

A. LESLIE ARMSTRONG.

14 Swaledale Rd.,
Sheffield, June 25.

Ancient Science.

PERMIT me to supplement two passages in NATURE of June 20.

P. 963, *Accuracy of Weighing in the Eighth Century*.—In 1885 I found a hoard of fifty-eight Athenian tetradrachms of uniform type and unworn condition. I reduced the chloride on each by means of zinc, and so obtained the original weights. The average was 264.2 grains, with a mean variation of 0.6 grain. Thus 4/5 of the coinage of Athens would have passed the remedy of the Mint in modern England. This must evidently have been the result of careful weighing and adjustment. In a group of small Gaulish silver coins, from Chalons-sur-Saône, which I bought in Paris, the average is 29.85 grains and the mean variation 0.33 grain, so it is evident the balance was used in Gaul. Weights are found in prehistoric Egypt so far back as 8000 B.C.

P. 937, *Egyptian Mathematics*.—The most frequent kind of problem in the Egyptian mathematical papyrus, that of dividing a stock of food, seems to be the origin of their fractional system. If 2 loaves have to be divided among 7 people, the obvious way

is to divide the stock into 8 parts, distribute 7, and divide the remaining quarter of a loaf into 7 parts. Thus $2/7$ naturally becomes $1/4 + 1/28$. The same system was used in dividing the profits of Scotch fishing-boats. The master served out a pound to himself, a pound to each of his crew, and a pound for the boat. When there were not enough pounds to go round, the remainder was changed into half-sovereigns, the next remainder into half-crowns, then shillings, then pence, and finally sweeties. The system seems obvious in all cases where written accounts were not prepared.

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On the Daily Use of an Immersion Condenser.

IN daily observations on the structure of chromosomes fixed and stained in iron-acetocarmine (see *American Naturalist*, 1921, pp. 573-574), where the limit of resolution in the microscope must be maintained, it has been determined that water is, on the whole, to be preferred to cedar oil as an immersion fluid for the condenser. The corrections necessary are readily made. (1) By centring a large enough meniscus lens from a photographic camera below the condenser (Hartridge); and varying the distance of the light source, and the thickness of the object slide, until the best image of a grating close to the light source is obtained. (2) By unscrewing sufficiently the top lens or lenses of the condenser. Slides can easily be selected of approximately the required thickness. The test for aplanatism is, of course, to diaphragm the source of light until its image is equal to or smaller than the field of view, and then observe the light circle at the back of the objective.

Cells in iron-acetocarmine become plastic after a certain time, and can be squeezed flat by slight pressure. When the chromosomes are thus spread out in contact with the cover-glass there is a good opportunity to seek for possible visibility of the chains of genes, either with the Watson dark field condenser of 1.3-1.4 aperture, or with the arc and two tourmalines, as mentioned by Beck in his lately published manual.

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The Faraday Benzene Centenary and Kekulé.

IN connexion with the benzene centenary, it may perhaps be pointed out that the name Kekulé is not French. August Kekulé, born in Darmstadt (1829; he died in Bonn, 1896), was a descendant of Wilhelm Dionysius Kekule (or Keckhule) von Stradonitz, who came from Bohemia in the seventeenth century. The é was probably adopted to guard against the suppression of the final e; that has been done in other cases. August Kekulé himself spelt his name with é, even in his earliest papers, before he went to Ghent and Bonn, and still in 1890, when his researches on the construction of aromatic compounds and the twenty-fifth anniversary of his benzene-hexagon (Bonn, 1865) were commemorated by an international Kekulé celebration at Berlin. But he had by that time (1890) resumed the full name A. K. von Stradonitz. The present members of the family spell their name without the accent.

H. BORN.

Chiswick, June 30.

Ether-Drift Experiments at Mount Wilson.

By Prof. DAYTON C. MILLER, Case School of Applied Science, Cleveland, Ohio.

THE Michelson-Morley experiment for determining the relative motion of the earth and the luminiferous ether, the "ether-drift experiment," was first performed in Cleveland in the year 1887, by Prof. Albert A. Michelson and the late Prof. Edward W. Morley. The theory of the experiment and a description of the apparatus was published in the *Philosophical Magazine* for 1887, and has been repeated in many text-books since that time. They announced their conclusions as follows: "Considering the motion of the earth in its orbit only . . . the observations show that the relative motion of the earth and the ether is probably less than one-sixth the earth's orbital velocity and certainly less than one-fourth." (That is, it is less than 7.5 kilometres per second.) This result was considered by many as a null result, often called a negative result, and by some was thought to throw grave doubts upon the validity of the hypothesis of the luminiferous ether.

At the International Congress of Physics, held in Paris in 1900, Lord Kelvin expressed the conviction that the experiment should be repeated with a more sensitive apparatus. The present writer, in collaboration with Prof. Morley, constructed an interferometer about four times as sensitive as that used in the first experiments, having a light path of 224 feet, equal to about 150,000,000 wave-lengths. In this instrument a relative velocity of the earth and ether equal to the earth's orbital velocity would be indicated by a displacement of the interference fringes equal to 1.5 fringes. This apparatus was used in the basement of the Physical Laboratory of Case School of Applied Science in Cleveland, observations being made in 1904 and 1905. The result of these observations was published in the *Philosophical Magazine* for May 1905, as follows: "We may, therefore, declare that the experiment shows that if the ether near the apparatus did not move with it, the difference in velocity was less than 3.5 kilometres per second unless the effect on the materials annulled the effect sought. Some have thought that this experiment only proves that the ether in a certain basement-room is carried along with it. We desire, therefore, to place the apparatus on a hill to see if an effect can be there detected."

In the autumn of 1905 Morley and Miller removed this interferometer from the college laboratory to a site on Euclid Heights, Cleveland, at an altitude of 300 feet above Lake Erie and free from obstruction of buildings. Five preliminary observations were made which gave indication of a positive effect as of an ether-drift of about one-tenth of the then expected drift. We were compelled to discontinue these experiments by circumstances beyond our control, before any definite results could be obtained.

The indication of a small positive effect made it seem necessary to continue the experiments, but it was thought desirable that further observations should be carried out at a much higher altitude. Prof. Morley retired from active work in 1906 and the continuance of the observations was long delayed. The suitable opportunity for continuing the experiments came in

1921, and upon the invitation of Prof. George E. Hale, Director of the Mount Wilson Observatory in California, the interferometer which had been used in 1905 was remounted at the Mount Wilson Observatory. Four distinct groups of observations have now been made in this location: in March and April 1921, in November and December 1921, in August and September 1924, and in March and April 1925. The first observations at this Observatory gave a definite, positive result considerably larger than that previously obtained in Cleveland, being equal to about one-third of the earth's orbital velocity.

On the simple theory of the ether-drift experiment, it is presumed that the system of interference fringes which is observed will suffer a periodic displacement as the interferometer is rotated in the horizontal plane, this displacement being proportional to the relative motion of the earth and the ether. The rotation of the earth on its axis causes the plane of the interferometer to move as though it were on the surface of a cone the axis of which coincides with that of the earth, and thus to take many different space orientations. It is only that component of the actual drift which lies in the horizontal plane of the interferometer at the moment of observation which can be observed. Therefore, the apparent azimuth and magnitude of the drift should change with the time of observation. A drift perpendicular to the plane of the interferometer will produce no effect whatever; it is quite possible that this condition may occur at certain times of the year.

It was suggested that the small observed effect might be due to magnetism acting on the steel frame of the interferometer, or that it might be due to radiant heat or other instrumental disturbances. The trying out of the various suggestions has involved continuous experimentation during the last four years, in which time every suspected cause of disturbance has been investigated, and it has been shown that none of these causes is responsible for the observed displacement.

In the summer of 1921 the steel frame of the interferometer was dismantled and a base of one piece of concrete reinforced with brass was cast in place on the mercury float. All the metal parts were made of aluminium or brass; thus the entire apparatus was free from magnetic effects and the possible effects due to heat were much reduced. In December 1921, 42 sets of observations consisting of 900 single measures of the drift were made with the non-magnetic interferometer. These show a positive effect as of an ether-drift which is entirely consistent with the observations of April 1921. Many variations of incidental conditions were tried at this epoch. Observations were made with rotations of the interferometer clockwise and counter-clockwise, with a rapid rotation and a very slow rotation, with the interferometer extremely out of level, due to the loading of the float on one side. Many variations of procedure in observing and recording were tried. The results of the observations were not affected by any of these changes.

The entire apparatus was returned to the laboratory

in Cleveland. During the years 1922 and 1923, many trials were made under various conditions which could be controlled and with many modifications of the arrangements of parts of the apparatus. An arrangement of prisms and mirrors was made so that the source of light could be placed outside the observing room, and a further complication of mirrors was tried for observing the fringes from a stationary telescope. Methods of photographic registration by means of a motion picture camera were tried. Various sources of light were employed, including sunlight and the electric arc. Finally, an arrangement was perfected for making observations with an astronomical telescope having an objective of five inches aperture and a magnification of fifty diameters. The source of light adopted was a large acetylene lamp of the kind commonly used for automobile headlights. An extended series of experiments was made to determine the influence of inequality of temperature and of radiant heat, and various insulating covers were provided for the base of the interferometer and for the light path. These experiments proved that under the conditions of actual observation, the periodic displacement could not possibly be produced by temperature effects. An extended investigation in the laboratory demonstrated that the full-period effect mentioned in the preliminary report on the Mount Wilson observations is a necessary geometrical result of the adjustment of mirrors when fringes of finite width are used, and that the effect vanishes only for fringes of infinite width, as is presumed in the simple theory of the experiment.

In July 1924 the interferometer was taken again to Mount Wilson and mounted on a new site where the temperature conditions were more favourable than those of 1921. The interferometer house was also mounted with a different orientation. Again the observations showed a definite positive effect corresponding to the observations previously made at Mount Wilson. The observations on Mount Wilson were resumed in March 1925, and continued until about the middle of April, during which time 1600 measures of the drift were made. Again many variations in detail of arrangement of parts and in methods of observing were made without in any way altering the result. Throughout the latter epoch of observations the conditions were exceptionally good. The observations of April 1925 give results almost identical with those of April 1921, notwithstanding that the interferometer had been rebuilt and that a different system of illumination and different methods of observation were employed, and that it was mounted on a new site in a house differently oriented.

The interferometer readings being plotted, give

directly by harmonic analysis the azimuth and magnitude of the ether-drift. There are no corrections of any kind to be applied to the observed values. In the work so far, every reading of the drift made at Mount Wilson has been included at its full value; no observation has been omitted because it seemed to be poor, and no "weights" have been applied to reduce the influence on the result, since no assumption has been made as to the expected result. It may be added that while the readings are being made, neither the observer nor the recorder can form the slightest idea as to whether any periodicity is present, much less as to the direction or amount of such periodicity.

The ether-drift experiments at Mount Wilson during the last four years, 1921 to 1925, consisting of about 5000 single measures of the drift, lead to the conclusion that there is a positive displacement of the interference fringes, such as would be produced by a relative motion of the earth and the ether at this Observatory, of approximately ten kilometres per second, being about one-third of the orbital velocity of the earth. By comparison with the earlier Cleveland observations, this suggests a partial drag of the ether by the earth, which decreases with altitude. A more extended account of these observations is given in the *Proceedings of the National Academy of Sciences* for June 1925.

Dr. Ludwik Silberstein, in his letter to *NATURE* of May 23, has pointed out that these results, indicating a partial drag of the ether by the earth, "are easily explicable by means of the Stokes' ether concept, as modified by Planck and Lorentz," as discussed in a paper by Silberstein in the *Philosophical Magazine* for February 1920.

The final test of these observations is whether they lead to a rational and wholly consistent indication of a constant motion of the solar system in space, combined with the orbital motion of the earth and the daily rotation on its axis. There is a specific relation for a given latitude between the observed azimuth of drift and the sidereal time of observation. Observations at different sidereal times should show different azimuths, and all observations at the same sidereal time should show the same azimuth for a given epoch. It is believed that a reconsideration of the Cleveland observations, from this point of view, will show that they are in accordance with this presumption, and will lead to the conclusion that the Michelson-Morley experiment does not and probably never has given a true zero result. A complete calculation of the observations, now in progress, together with further experiments to be made in the immediate future, should give definite indications regarding the absolute motion of the solar system in space.

The Science Exhibition at Wembley.

THE Science Exhibition arranged by a Committee of the Royal Society in the Government Pavilion at Wembley represents a great advance on the similar exhibition held last year, particularly as regards the section devoted to physics. The space available has been considerably extended and the equipment of the demonstration benches is much more adequate. Perhaps the most striking advance, however, is the admirable systematic manner in which it is now possible to

present the exhibits, for these have been arranged on an underlying plan which gives unity to the whole and converts a collection of miscellaneous experiments into an orderly sequence of demonstrations, which are not only striking in themselves but also calculated to give visitors a very fair impression of the nature of modern physics and the scope of the problems to which it addresses itself. The key to this part of the exhibition is to be found in an enormous chart, some 24 ft. long,

showing the wave-lengths of electromagnetic radiation as a continuous series according to a logarithmic scale, the general nature of the radiation and the methods by which it is detected and generated being shown against each range of wave-lengths. This chart itself, which covers 60 octaves, is of considerable interest, particularly as regards the regions of overlap. For example, it has in recent years become possible to generate and detect radiation the wave-length of which is a few tenths of a millimetre both by thermal and by electromagnetic methods. It is a remarkable fact that it is now possible to use a scale of wave-lengths as a guide to a very representative series of physical experiments: it emphasises the change which has taken place in the orientation of scientific thought since the days when matter was everything and energy had not been defined, for now energy is paramount and matter is mentioned as an afterthought.

Bearing in mind the general scheme indicated by the chart, the visitor is conducted along a series of excellently appointed benches designed to illustrate the properties of the various types of radiation, beginning with the shortest. He is first introduced to the atom, as the source of gamma radiation, and this is represented by some new models in addition to apparatus which will be familiar to physicists. On the ceiling the relative distances of the electrons and nucleus in a neon atom are shown by means of coloured lamps, and further models, for which Prof. W. L. Bragg and Mr. D. R. Hartree are to be responsible, are awaited with interest. Another striking exhibit connected with atomic structure is an apparatus from the Clarendon Laboratory in which a single particle at a time, emitted by polonium, is made to break down the resistance of a small spark gap, the resulting current being made audible, by means of amplifiers and a loud speaker. The properties of gamma rays are illustrated by a projection electroscope contributed by Dr. E. A. Owen, the rate of discharge being varied by placing various screens in the path of gamma rays emitted by radium.

Amongst the experiments connected with X-ray apparatus may be noted a very fine demonstration due to Mr. F. D. Edwards of the electric discharge through air at gradually decreasing pressure in a tube 4 ft. 6 in. long. The large scale of the apparatus makes these always beautiful effects very striking, and the rise in resistance of the tube at the highest and lowest pressures is indicated by sparks across a 10-inch alternative gap. A less familiar demonstration is afforded by de la Rive's apparatus, in which a luminous arc passes from an electrode at the top of a discharge tube to a ring electrode at the bottom, the core of an electromagnet being located in the axis of the ring. The arc is seen to rotate in one direction or the other according to the polarity imparted to the electromagnet. Dr. G. W. C. Kaye contributes a soft X-ray apparatus with which visitors can study the transparency of various substances by the aid of a fluorescent screen, and there are exhibits illustrating the application of X-rays to crystal structure. Bridging the gap between X-rays and ordinary ultra-violet light we have the Schumann X-rays, produced by the impact of electrons the velocity of which is measured by some hundred volts, and detected by their photo-electric effect on the insulated electrode of an electro-

meter. It was in this region that the "death-ray" was alleged to lie.

The ultra-violet range is illustrated by several demonstrations of which the most intriguing is perhaps one due to Sir Herbert Jackson, in which mixed visible and ultra-violet rays from a condensed aluminium spark are focussed by a quartz lens on a screen which fluoresces to ultra-violet rays of wave-length 1850 or 1860 Å.U. The visible rays are found to be focussed at about 2 ft. from the lens and the ultra-violet of the above wave-lengths at about 8 inches, so that by moving the screen it is possible to find two differently coloured focal regions. Mr. Guild contributes a visible spectrum projected by means of a calcite prism. The existence of radiation beyond the visible spectrum is shown by means of a thermopile at one end and a zinc sulphide screen at the other, and the effect of interposing various colour filters is shown by a comparison of the filtered spectrum with a patch of otherwise white light which has passed through the filter. Dr. Curtis shows that on increasing an electric discharge through nitrogen by shunting the break of the induction coil with a condenser, the disruption of the nitrogen molecules changes a band spectrum into a line spectrum, and a similar contrast is obtained by Prof. Fowler by means of a flame arc containing calcium fluoride, the band spectrum due to the fluoride being accompanied by a line spectrum due to the dissociated elements. Prof. Horton and Dr. Ann Davies illustrate the nature of light emission with an apparatus for showing excitation potentials, and there are photoelectric cells in action contributed by the Clarendon Laboratory and Mr. T. H. Harrison. Interference phenomena in the visible range are represented by a Michelson interferometer (Mr. Twyman), Lippmann colour-photographs (Mr. Gamble), diffraction gratings from the National Physical Laboratory (Mr. J. S. Clark), and a demonstration due to Prof. Rankine of the projection of an image of a luminous object by means of a spherical bicycle ball in place of a lens. Each point in the object throws a circular shadow of the ball having a white spot at its centre, and the aggregate of white spots forms the required image. Photographs can be reproduced by this method. Polarisation apparatus is shown by Prof. Cheshire.

For the infra-red region Mr. Twyman has a spectrometer with a rock-salt prism which can be turned by a micrometer screw so as to traverse the spectrum across a thermopile. The spectrum from 5,000 to 100,000 Å.U. can be explored in this way, and a Bunsen burner is shown to emit strongly in the neighbourhood of 44,000 Å.U. A caesium photo-electric cell, which is sensitive to infra-red rays, is contributed by the Clarendon Laboratory, an ebonite screen serving to filter out the visible light. The transition to wireless wave-lengths is afforded by Mr. F. E. Smith's demonstration of the production and heating effects of very short Hertzian waves, and by Sir William Bragg's example of Lindman's apparatus for rotating the plane of polarisation of such waves by means of an arrangement of metal spirals, the action being similar to that of quartz and other crystals which are optically active in the visible region.

The interest of the non-scientific visitor, for whose benefit the Exhibition is primarily intended, will no doubt be specially caught by the display of wireless

apparatus, of which a few examples only can be mentioned. The Lecher wires (Prof. Whiddington) will illuminate the conception of wave-length, and apparatus by Dr. Smith-Rose demonstrates the rectifying property on which crystal detectors depend. The determination of absolute frequency by Mr. D. W. Dye's recently perfected oscillograph system is also a feature in this section of the Exhibition. The cathode-ray oscillograph is caused to give a circular trace by means of crossed fields controlled through a valve by a standard tuning-fork, the ray completing the trace once per vibration of the fork. By the superimposition of a supplementary pair of crossed fields at high frequency the circular trace is transformed into a closed series of loops when the frequency is a harmonic of the fork frequency, and can be calculated from that and the number of loops. In this way standardised high frequencies can be obtained. The same apparatus is used to give wave form by transforming the circle into a long ellipse, and adding to the deflecting field which gives the minor diameters a further deflecting field proportional to the high frequency voltage. If the eccentricity of the ellipse be sufficient, the time base is substantially rectilinear and uniform. Direction finding is demonstrated by Dr. Smith-Rose, the currents produced in a rotatable coil by a neighbouring oscillator being read off from a galvanometer. Possibly if a pointer were fixed to the coil with its tip moving over a set of equidistant straight lines forming a scale, the galvanometer reading could be adjusted to give directly the sine of the inclination of the coil to the wave front, as indicated by the tip of the pointer. The General Electric Company illustrates in a striking way the problem of uneven filament-heating. In a diode valve the filament heating current is an A.C. from the source that supplies the anode volts, but the phase of the filament current can be varied. The brightest point on the filament is seen to move along the latter as the phase alters. The longest electromagnetic wave-lengths are represented by some experiments on audio-frequency currents.

Amongst the geophysical apparatus must be mentioned a working installation of the new Milne-Shaw

seismograph, which employs an optical lever and Foucault-current damping. This instrument is exceedingly sensitive, giving a magnification of 500, and can even indicate the tilt of a coast due to tidal load. Records of the Japanese earthquake of September 1923 are exhibited.

The biological exhibits include all those which proved most attractive last year together with some additions, amongst which may be mentioned Prof. Groom's cultures of various species of fungus causing dry-rot in timber. Prof. Harris shows an apparatus for measuring the oxygen pressure of fresh blood, the blood and a comparison solution being contained in two quartz bottles which can be exposed to light containing ultra-violet radiation. It is shown that exposure to light promotes the absorption of oxygen and so alters the equilibrium point between the oxygen in the blood sample and that in the air above it. Dr. E. H. J. Schuster shows a respiration pump by means of which a detached organ or a headless trunk can be kept alive for some hours. In connexion with physiological demonstrations it is perhaps well to remind the public that with a few rare exceptions British biologists have been humane men who have recognised the imperative duty of using anaesthetics in experiments on living animals. In the physiological section is also classified an apparatus for measuring the compressional elasticity of films of fatty substances on water. The water surface is swept clean and the film is compressed by means of a measured force applied to a floating strip. The films are found to be monomolecular. The method has been used for estimating very small amounts of fat.

An attractive innovation is a miniature kinematographic projector by Kodak for which a number of scientific films have been obtained, including some high-speed films taken with the Heape and Grylls machine.

The Exhibition as a whole is an admirably conceived attempt to instruct the public as to the methods and aims of science, and is entitled to the support of all who have the interests of scientific prestige at heart. In conducting their unscientific friends through the series of demonstrations provided they will themselves derive no small profit and enjoyment. C. W. H.

Problems of the Rhone Delta.¹

By R. D. OLDHAM, F.R.S.

III.

THE eastern branch of the Rhone has undergone changes, as extensive and remarkable as those of the western, though differing in character. In the early centuries of our era the mouth of the river is put, in the maritime itinerary of the Antonines, at 16 Roman miles from the port of Fossæ Marianæ, and from thence it was 30 miles by river to Arles. These distances fix the mouth of the river close by the present termination of the Vieux Rhône, or main channel during the seventeenth century, and this identification is borne out by the finding, in 1883, of an old boundary pillar with a Latin inscription, regarded as fifth or sixth century, which appears to show that it was set up near to the mouth of the Rhone. The place where it was found lies 3 km. west of the old river channel and 2 km. inland

from the sea-face of the delta, and, whatever may be the exact age of this inscription, it must date from before the subsidence in the Dark Ages.

This subsidence brought about great changes; a large part of the seaward portion of the delta was submerged, leaving numerous islands of various sizes, the memory of which is partially preserved in local place-names, and the mouth of the river proper receded to near, but not up to, the town of Arles.

When light again begins to dawn on the history of this region we find, in the description, by Roger de Hoveden, of the voyage of an English fleet along the coast in 1190, a statement that they passed an island called Odur, at the mouth of the Rhone, going up which river brings one to the fine city of Arles le Blanc. The identification of this Odur is certain; it is known at the present day as the Roque de Dour, or more simply La

¹ Continued from p. 19.

Roque, a low hill of about 25 feet high, rising from the alluvium of the delta, just west of the entrance to the Étang de Galéjon. In the form of Odor or Dor it appears on all the portolan maps, being given equal prominence with other more conspicuous towns, ports or landmarks, and evidently owed this prominence to its importance as marking the entry to the main channel leading to Arles. On a flat, low-lying coast, often indistinguishable in hazy weather, even so small a hill would form an important landmark.

The course of this channel can still be traced; it was up the Étang de Galéjon, and then westwards along the general course of an old river channel, known as the Bras Mort, to the neighbourhood of the village of Passon, on the banks of the Rhone. Along this line there is a strip of low-lying modern alluvium, bordered on both sides by higher ground, part of the old land surface of the Roman period. The Bras Mort was practicable for small boats, at any rate during part of the year, until it was artificially closed in 1642, but long before that it had ceased to be navigable by ships. The channel was, however, still in use at the beginning of the fifteenth century, and is described in a portolan, or book of sailing directions, printed at Venice in 1490, evidently from old manuscripts works of similar character, dating from the early part of the century.

The advance of the mouth of the river and successive closing of alternative channels of access to the town and port of Arles can be traced in the records of that city. From the commencement of the Middle Ages it claimed, and exercised, a control over the navigation of the Rhone, and, for the purpose of this control, maintained an armed and fortified post for the double purpose of levying tolls on the shipping and excluding undesirable, or piratical, intruders. The latter purpose made it desirable that the post should be as distant as possible from Arles itself; the former compelled it to be situated so near that the traffic had to pass it, that is to say, above the highest point where there was an alternative channel to the open sea.

The earliest of these fortified posts or towers of which there is record was the Tour de Malusclat; the exact position of this has not been identified, but the name remains as that of a village, and it must have been on the western bank of the river a couple of miles or so above Passon, the place where the old channel from the Galéjon joined what is now the main stream of the Rhone. The date of construction of this tower is not known, but, about the middle of the fifteenth century, the advance of the mouth of the river having reached the neighbourhood of Passon, the channel leading to the Étang de Galéjon, and the Roque de Dour, became blocked by the alluvial deposits of the river, thereby closing what had been the principal channel of access. This made the situation of Tour de Malusclat no longer suitable, and, in 1469, the Council of Arles decided that it should be demolished and a new tower built farther down the channel:

The site of this new tower, afterwards known as the Tour de Belvar or Bolovard, has been identified, in the lands of the Grand Peloux, close to the left bank of the present channel, and nearly opposite where the Bras de Fer channel takes off from the river. It was not, as has been stated in some modern works, built on the actual sea-face of the delta, for maps of the seventeenth century, and records of law suits and grants of land in the thirteenth, show that there was land to the southwards, but the site was chosen because it lay at the junction of two alternative channels of access, and was the site, farthest from the city of Arles, at which the whole traffic of the river could be controlled by a single post. It remained in function for more than a century, during which the principal channel led southwards,

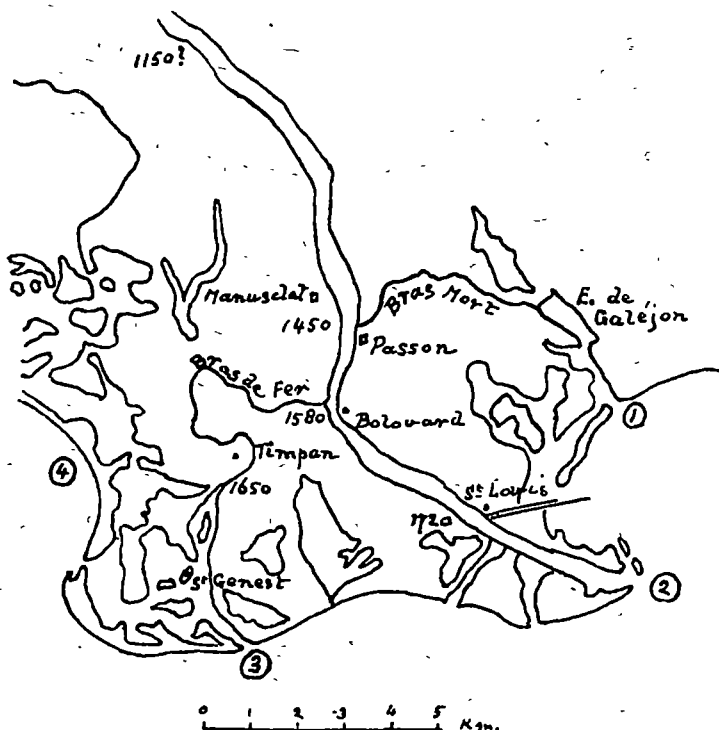


FIG. 4.—Lower course and mouth of the Rhone, showing position of the successive towers, approximate position of the mouth of the river at the dates indicated, and main channels of navigation. (1) Up to about 1450. (2) Until 1585 and again from 1720 to the present day. (3) From about 1585 to 1720. (4) Alternative channel, finally blocked about 1650

much along the general course of the existing river channel. By 1587 the mouth of the river proper had advanced to this place, and the river, instead of continuing along the direct channel, broke away to the westwards, to follow the general course of the Bras de Fer.

The Tour de Bolovard was thus left stranded and, after a while, sold and demolished, all but the foundations, which still remain. Meanwhile, a new tower had been built, in 1607, known as the Tour de Tampan, on the banks of the Vieux Rhône, and about 8 km. inland from the present coast-line. Here, again, the tower was not built on the sea-face, for old maps show that a group of islands, separated by channels, extended out to very near the existing sea-face of the delta; the site was evidently selected because, in addition to the channel afterwards followed by the river, there was another navigable channel, called the Rajeirol, which led, from a little below the tower, into the Golfe de Beauduc.

In course of time the river mouth passed this channel and blocked it up, so the Tour de Tampan was abandoned and a new one, the Tour de St. Genest, was built, in 1656, on what was evidently an island of the old land surface of Roman times, and not far from the spot where the boundary stone with Latin inscription was discovered in 1883.

This tower, at last, lay close to the sea-face of the delta; the most advanced outpost of the old land was not much more than a mile to the southwards, and, when the river extended past this point, it no longer ended in a sheltered inlet, but in the open sea. The formation of an extension of the delta, by the silt brought down the river, began, and a difficult and dangerous bar developed, the hindrance to navigation becoming more acute as the river mouth was pushed farther out into the open sea. Many schemes and proposals for remedying this were considered, during the latter half of the seventeenth century, but none had been initiated when, in 1711, the river broke away along the line of the old navigable channel, past the site of the Tour de Bolovard, to enter the sea close by the place where, in 1737, the Tour St. Louis was built, close to the sea-face of the land, as it then stood. Since then there has been no further change in the channels farther up-

stream, and the whole river is so firmly controlled by protective embankments that none is likely to occur.

From this brief history it appears that the mouth of the Rhone, which was near Passon about the middle of the fifteenth century, had advanced to the present coast-line at the Vieux Rhône by the middle of the seventeenth, and early in the following century was at the coast-line of that time near the modern town of St. Louis. This advance of the mouth of the river does not, however, mean a growth of the delta by a depth of ten kilometres along a breadth of about twenty; this would mean an increase of nearly a square kilometre a year, fully five times the rate of growth of the delta during the last two centuries. It was, however, not from the open sea that the land was reclaimed, but from a number of shallow channels separating islands of old alluvium, thus reducing largely both the area and depth of the new deposits, and in this way the changes, which are known to have taken place, are not merely to be explained by subsidence of the land during the Dark Ages, but in themselves become evidence of the reality of the change of level, independently deduced from evidence of a wholly different character.

(To be continued.)

Two New Elements of the Manganese Group.

THE recent discovery of the two missing elements of the manganese group by Dr. Noddack and Fräulein Tacke of Berlin is of interest not only as an important step towards the completion of the periodic table but also on account of the methods used in the research. In these days no one branch of science can afford to stand aloof from the others, and perhaps it would be difficult to find a happier example of the way in which the various sciences can combine towards a successful result than this discovery of the eka-manganeses. Chemistry, physics and mineralogy have all played their parts, and the result is that the number of gaps between hydrogen and uranium in the periodic table has been reduced from five to three.

In the preliminary account of their work which has been published in *Die Naturwissenschaften* for June 26, p. 567, the authors give, in addition to the results of their investigations, the arguments on which their line of attack was based. In the first place, it was necessary to find some material in which the new elements might reasonably be expected to occur. A study of the neighbouring elements suggested two possible sources; the first that of the platinum ores, the second a mineral such as columbite. The platinum ores contain the elements chromium to copper, ruthenium to silver, osmium to gold, or, expressed in atomic numbers, 24 to 29, 44 to 47, and 76 to 79. Columbite, on the other hand, contains, among many other elements, those of atomic number 39 to 42 and 71 to 74. Here, therefore, were two minerals in either of which the missing elements 43 and 75 might well be found.

In endeavouring to form an estimate of the amounts of the elements 43 and 75 which might be present in these minerals, the authors employed an ingenious argument. The constitution of the earth's crust is now fairly well known, and it is possible to assign to the various elements numbers indicating the frequency

of their occurrence. A study of these figures indicates that elements of odd atomic number are less common than those of even atomic number; in fact, an odd element is ten or twenty times less abundant than the succeeding even element. As ruthenium (44) and osmium (76) constitute about 2×10^{-12} and 2×10^{-11} of the earth's crust, it was deduced that the elements 43 and 75 would form about 10^{-13} and 10^{-12} of the earth's outer layer. As the frequency of occurrence of platinum is 10^{-9} , the amount of the elements 43 and 75 in the platinum ores should be from 10^{-3} to 10^{-4} , and as niobium, one of the chief constituents of columbite, forms 10^{-7} of the earth's surface, columbite was estimated to contain from 10^{-6} to 10^{-6} of the missing elements. In this way Drs. Noddack and Tacke obtained some idea of the extent to which the chemical processes of extraction would have to be carried if measurable quantities of the new substances were to be obtained.

It was a fairly straightforward matter to predict some of the chemical properties of the new elements from a consideration of their neighbours in the periodic table. Thus it appeared probable that both would form oxides X_2O_7 , and that these oxides would readily sublime on account of the small difference of temperature between their melting- and boiling-points. Again, for example, it was argued that the eka-manganeses would resemble chromium in so far as no sulphides would be formed from aqueous solutions. These and other chemical properties were used in the chemical treatment of the ores.

Attention was first directed to the platinum ores as offering the highest chance of success. After preliminary chemical treatment, the residue of 80 gm. of a Russian ore was strongly heated alternately in oxygen and hydrogen. Among the deposits on the walls of the vessel was found a very small quantity of white microscopic needle crystals. These needles became dark in

colour when treated with a stream of hydrogen sulphide, while a subsequent heating in oxygen resulted in the reappearance of the white sublimation product on the colder part of the vessel. An aqueous solution of these crystals gave no precipitate either with hydrogen sulphide or ammonium sulphide. As such behaviour was to be expected from the elements 43 and 75 and from none of the other known elements in the solution, it was presumed that this substance contained the missing elements. Further attempts at concentration resulted in a loss of the material.

Through lack of further supplies of the platinum ores, the authors turned their attention to columbite, resolving at the same time to carry out the final analysis by X-rays. From about 1 kgm. of the mineral the greater part of the iron, niobium and tantalum was removed by sodium hydroxide and sodium nitrate; the filtered solution was treated with hydrogen sulphide and concentrated to a volume of 50 c.c. By the use of mercurous nitrate, about one gram of precipitate was obtained from this solution. A repetition of the process gave about 50 mgm., estimated to contain about 5 per cent. of the elements 43 and 75. Heating in oxygen gave once more the white sublimate. The quantity available was too small for direct application to the anticathode of the X-ray tube. It was, therefore, mixed with niobic acid and examined spectroscopically in this form.

X-ray spectra probably provide the best method for the detection of a small quantity (say 0.1 per cent.) of an element in a mixture. These spectra are much simpler in nature than the optical spectra, and, unlike the latter, do not depend on the mode of excitation or on the state of chemical combination. The wave-lengths are determined by the atomic number alone. From Moseley's laws it is possible to predict the wave-lengths of the various lines with considerable accuracy. A further check is provided by an examination of the relative intensities of the lines. An X-ray investigation of the final products of the chemical processes was

carried out by Drs. Berg and Tacke, and a search made for the *K* series of the element 43 and for the *L* series of 75. The result was entirely successful. Three lines appeared on the plates corresponding to wave-lengths 0.601, 0.672 and 0.675 Å.U., whereas the calculated values of the $K\beta_1$, $K\alpha_1$ and $K\alpha_2$ lines for an element 43 are 0.600, 0.673 and 0.678 Å.U. These are the three strong lines in the *K* series, and their relative intensities agreed with the well-known ratios. In the spectral region 1.20 to 1.43 Å.U. there occurred five lines which were identified as the $L\alpha_1$, $L\alpha_2$, $L\beta_1$, $L\beta_2$ and $L\beta_3$ lines of an element of atomic number 75. The numerical agreement was excellent; thus, the observed and calculated wave-lengths of the $L\alpha_1$ line were 1.4299 and 1.4306 Å.U. There is always a chance that the lines may be wrongly identified, but the authors appear to have taken due precautions against any possible misinterpretation, and there seems no doubt that these lines are actually due to the presence in the columbite residue of the elements 43 and 75.

As a result of this careful research work, the existence on the earth of the elements of atomic number 43 and 75 appears to be definitely established, a fact which is all the more interesting because certain writers have put forward arguments suggesting that a search for the eka-manganeses must prove fruitless. The actual amount of the new elements in columbite is estimated as from 10^{-6} to 10^{-7} , or somewhat less than the proportion indicated by the calculations outlined above. The chemical and physical properties appear to be closely related to those predicted by an examination of their neighbours, but no doubt more details will soon be available when greater quantities of the new elements have been isolated.

The authors suggest that the two newly discovered elements should be named Masurium (Ma) and Rhenium (Re) after the district of Eastern Prussia and after the Rhine respectively. Whether these names will meet with such widespread approval as the research itself remains to be seen.

Current Topics and Events.

IN celebration of the 250th anniversary of the foundation of the Royal Observatory, Greenwich, their Majesties the King and Queen will pay a visit to the Observatory on July 23. We understand that they will be received in the Octagon Room, the original Observatory, by members of the Board of Admiralty and of the Board of Visitors of the Royal Observatory, and will then be conducted over the buildings and shown the principal instruments. On the evening of the same day a *conversazione* is being given by the president and council of the Royal Society to meet the delegates to the International Astronomical Union. On the following day an official luncheon is being given, presided over by the First Lord of the Admiralty.

AFTER nearly two years' effort, the Australian National Research Council has succeeded in its project for establishing a Commonwealth School of Anthropology, to be attached to the University of Sydney. In December 1923 the Commonwealth Government expressed approval of a scheme sub-

mitted to it; in the following year, however, an officer selected by the British Government to advise Australia in the matter of administration of Territories, reported very strongly against the proposal to use such a school for the training of officials. In consequence, Government interest flagged. Renewed efforts, supported by the Australasian Association for the Advancement of Science and the universities, were made in September, and, largely as the result of a visit from Prof. Elliot Smith, who brought unofficial word of warm American sympathy, the Prime Minister promised to provide 1000*l.* per annum towards the expenses of a chair. The estimated yearly requirement being 2500*l.*, the respective States were then asked to contribute the balance of 1500*l.* between them on a population basis. New South Wales, Victoria, Queensland and Tasmania agreed to provide their shares, and South Australia is practically certain to fall into line; Western Australia remains uncertain. The Research Council, therefore, has now asked the Senate of the University of Sydney to consider the immediate appointment of a professor

and the general arrangements for the new school. In doing so, it has laid emphasis on the following points: (a) The main work of the chair both in teaching and research should be in the field of social anthropology rather than on the physical or anatomical side, though provision should be made for this also. (b) In view of the training of students for Government service in Papua and the Mandated Territories, and for specialised work in the Pacific, the professor chosen should have had actual field experience. (c) Though the routine work of the new chair will be under the control of the University of Sydney, it is urged that a permanent Advisory Committee, containing representatives of the Commonwealth, States and Research Council, should be appointed, to assist in the organisation of field research.

AN international conference is shortly to be held at The Hague on the subject of industrial property, that is to say, on patents, trade marks, and designs. It is a matter of considerable importance that Great Britain should be represented by delegates who have had wide experience in patent practice, but if the conference held in 1922 on the proposed Empire patent is to be taken as a precedent, it may be gravely doubted whether any such precaution will be taken. It will be remembered that at that conference the Comptroller was accompanied only by representatives of the clerical staff of the Patent Office, to the exclusion of representatives of the scientific staff who would have possessed both legal and technical training and experience. It is not surprising, in these circumstances, that the conference failed to produce any result, for the very delicate technical question arose of an Empire "search," or examination of all relevant British Empire patent specifications, before granting a patent, and none of the British representatives had that direct acquaintance with the "search" which might have enabled them to deal with this thorny problem in such a way as to satisfy the *amour propre* of the Dominion Governments. It would be far more serious, however, if Great Britain were to be unsuitably represented at an international conference, particularly if the Comptroller should be unable to attend in person. The effect of a given change in international patent practice cannot be instantly grasped by any one who lacks extensive experience of patents, and the interests of British manufacturers may inadvertently be prejudiced by negotiators who are not adequately qualified for their work. We trust that, on the occasion of the impending international conference, full use will be made of the technical knowledge and experience of the Patent Office staff.

THE Santa Barbara earthquakes at the end of last month prove to have been of less importance than the early accounts suggested. By the first, on June 29 at about 6.30 A.M. (2.30 P.M., G.M.T.), many buildings in Santa Barbara were destroyed or damaged (the loss being estimated at from three to six million pounds), twelve persons were killed, and water-mains were broken. The second, on June 30 at 1.22 A.M.,

is said to have equalled its predecessor in strength; while one of the after-shocks, on June 30 at 4.42 A.M., is described as severe. The area affected by the earthquakes was apparently small, and this seems to indicate that the depth of the foci was comparatively slight. In the neighbourhood of Santa Barbara there are several faults running east and west or parallel to the trend of the coast-line, and traversing longitudinally the Santa Inez and San Gabriel mountains. In the fault-map of California, issued by the Seismological Society of America, they are shown as inactive, but it would seem that they are rather in a state of moderate activity at long intervals. To one or more of these faults Dr. Bailey Willis attributes the group of strong earthquakes on November 27-30, 1852, and a local earthquake on July 30, 1902 (Bull. Seis. Soc. America, vol. 14, 1924, pp. 18-19). Between these shocks, on January 9, 1857, an earthquake, stronger than any of those mentioned above, was felt generally throughout southern California and severely in the Santa Barbara district. Dr. Willis assigns its origin to a movement along the extensive San Andreas fault, that with which the San Francisco earthquake of 1906 was connected.

A PRELIMINARY report on the Canadian earthquake of February 28 (NATURE, March 7, vol. 115, p. 347) has been issued by the seismologist of the Dominion Observatory (*Science*, vol. 61, 1925, p. 584). The epicentre of the earthquake is supposed to be in the mountainous region near the eastern boundary of the Laurentide Park. Its exact position is, however, at present unknown, the region being inaccessible when the first investigation of the central area was made. Many of the reports of the damage proved to be exaggerated or erroneous, but the amount was considerable at Quebec, Shawinigan Falls, Malbaie, St. Urbain, and the district near the Rivière Quelle. In every case of serious damage the ground was sand or clay, usually on the side of a hill, and the buildings were massive stone structures, without steel reinforcement, such as churches. A new seismograph station (the sixth in the Dominion) has been established by the Department of the Interior at Ste. Anne de la Pocatière, near the centre of the area affected by the earthquake of February 28.

JUNE established a record for its dryness, and almost a record for its duration of bright sunshine in England. At the Royal Observatory, Greenwich, according to the weather records published by the Registrar-General in the Weekly Return of Births and Deaths, rain fell only on two days, the measurements being 0.11 in. on June 24, and 0.01 in. on June 26, making a total of 0.12 in. for the month. The previous minimum rainfall at Greenwich in June since 1815, in 110 years, was in 1895 and was 0.21 in. The normal for 100 years to 1915, is 1.99 in., the normal for 35 years, 1881 to 1915, is 2.02 in., and the normal days with rain, 11. The smallest rainfall in any month of the year was in February 1821 and was 0.04 in., and in comparatively recent years, since 1900, the smallest monthly total was in April 1912 (0.07 in.), and in February 1921 (0.12 in.). There

was a drought from June 1 until 23. According to the weather correspondent of the *Times* (July 1), June 1925 was the driest June at Kew since records started in 1871, and also the sunniest. The total rain at Kew was 0.04 in. Ross-on-Wye, Calshot (near Southampton), and Falmouth are reported to have had no rain. The duration of bright sunshine at Greenwich was 251 hours, which averages 8.36 hours per day. In June 1914 the sun shone for 267 hours, which is 16 hours more than in June this year. The average duration in June for the 35 years 1881 to 1915 is 201 hours, 6.70 hours per day. The mean maximum shade temperature at Greenwich was 73°·1 F., which is 3°·1 above the normal, and the mean minimum was 49°·7 F., which is in precise agreement with the normal; the excess of heat was clearly due to the intense sunshine in the early part of the month.

We learn from *Science* that Dr. E. L. Thorndike, professor of educational psychology in Teachers College, Columbia University, has been awarded the Butler gold medal, given every five years by Columbia University for the most distinguished contribution to philosophy or to educational theory, practice or administration, for his contribution to the general problem of the measurement of human faculty and to the application of such measures to education.

THE third annual corporate meeting of the Institution of Chemical Engineering is to be held in the Philosophical Hall, Leeds, on July 17. Afterwards a joint meeting will be held with the American Institute of Chemical Engineers, at which addresses will be delivered by the presidents of the two bodies, Sir Arthur Duckham and Dr. Charles L. Reese, and a symposium on "Industrial Water Supply and Stream Pollution" will be presented. Visits to Messrs. Nobel Industries, Ltd., Messrs. Jos. Crosfield and Sons, Ltd., and the United Alkali Co., Ltd., and to various places of interest in Scotland and England, have been arranged to follow the meeting.

MR. T. R. FERENS, of Hull, is well known for his generous gifts for educational purposes, culminating in a gift of 250,000*l.* for a university college at Hull, referred to in our issue of February 14, p. 239. He has now presented a sum of 20,000*l.* to the Medical School of the Middlesex Hospital for the foundation of an Institute of Otology. The new institute, which will occupy for the present a part of the top floor of premises in Cleveland Street, to which patients from the Middlesex Hospital are being removed during rebuilding of the Hospital, will be devoted to research on the structure, functions, and diseases of the ear, nose, and throat, and it is intended to establish a laboratory, museum, and library.

PROF. R. RUGGLES GATES, professor of botany, University of London (King's College), is sailing from Liverpool on July 14, by the S.S. *Hildebrand*, on an expedition to the Amazon region. He will leave the ship at Manaus and spend a month collecting plant materials in that region and farther down the river. Returning from Para, he will reach England early in

October. Prof. Gates is taking Wardian cases to bring back living plants, and will also collect cytological and morphological material for research, as well as some dried specimens. He is also taking a photographic outfit, including a cinema camera and 3000 feet of film, and he expects to make some collections of plankton during the voyage and on the river.

THE control of the administration and the management of the Imperial Institute, South Kensington, has now been transferred, in accordance with the provisions of the Imperial Institute Act, 1925, from the Secretary of State for the Colonies to the Parliamentary Secretary, Department of Overseas Trade. The Imperial Mineral Resources Bureau was amalgamated with the Imperial Institute at the same time, and all correspondence relating to the work of the Bureau should be addressed to the Imperial Institute (Mineral Resources Department), South Kensington, London, S.W.7.

AT the time of going to press (July 8), a reception is being held in the Pavilion of His Majesty's Government at the British Empire Exhibition, and invitations have been issued to view the Science Exhibition arranged by a committee of the Royal Society. The guests are being received by the president of the Royal Society, Sir Charles Sherrington, and the chairman of the Committee organising the exhibits, Mr. F. E. Smith. The Exhibition this year is a decided advance on that of last year, as will be seen from the account indicating some of its main features which appears elsewhere in this issue (p. 50). The Committee responsible for it is to be congratulated on the very representative collection of demonstrations and exhibits brought together. In connexion with the Science Exhibition, a volume entitled "Phases of Modern Science" has been prepared, this includes articles by leading authorities on various aspects of modern scientific research, and a descriptive catalogue of the exhibits. It constitutes a most valuable statement of the present position of physical and biological science. The section describing the exhibits is also being issued separately and is obtainable in the Government Pavilion at Wembley.

THE ninety-third annual meeting of the British Medical Association will be held at Bath on July 21-24, under the presidency of Dr. F. G. Thomson, physician at the Royal United Hospital, Bath. The annual representative meeting of the Association will be on July 17-20. The president will deliver his address and also open the annual exhibition of surgical appliances, foods, drugs, and books on July 21. Sir William Bragg is to deliver a popular lecture during the evening of July 24. The provisional sectional programmes include discussions on the following subjects, the opener's name appearing in brackets after the subject: Endocrine therapy (Dr. W. Langdon Brown and Prof. Swale Vincent), filter-passing viruses (Dr. W. E. Gye), pathological basis of treatment by radiation (Prof. S. Russ), pathology and bacteriology in Great Britain, with special reference to research (Prof. J. C. G. Ledingham), therapeutic value of light

(Prof. W. E. Dixon), food manipulation and health (Dr. W. G. Savage), influence of sunlight and artificial light on health (Prof. L. Hill), and the purity standard of milk (Dr. R. Stenhouse Williams, Dr. W. G. Savage, Dr. E. Pritchard, Mr. W. Buckley, Mr. G. P. Male and Mr. J. H. Maggs, each discussing a different aspect). The honorary local general secretary for the meeting is Mr. W. G. Mumford (British Medical Association Committee Rooms, Assembly Rooms, Bath); and the honorary assistant secretary is Dr. R. G. Gordon.

DR. ALÉS HRDLIČKA, of Washington, is now travelling through India on the first stage of a survey of the field of early man and his predecessors in southern Asia, Australia, and Africa, on behalf of the Smithsonian Institution and the Buffalo Society of Natural Science. In the course of a letter to the former body, he has some interesting observations to make on what he had seen up to the time of writing. Of the physical character of the people he says that the main elements are unquestionably Mediterranean and Semitic, but there are also indications of a Hamitic mixture. He had intended to visit Karachi to investigate the curly-haired people there, but considered this unnecessary, as he was informed that they were known to be of African importation, and that if there were any such natives they must be somewhere at the head of the Persian Gulf, a region now impracticable to reach. At Simla he saw people from the Tibetan borders and some few even from Tibet. Among the latter was one woman who looked a typical American Indian; her dress also strongly suggested the Indian.

THE hundredth annual report of the Bath Royal Literary and Scientific Institution records an earnest effort on the part of the members to revive its interest and usefulness. The ceiling paintings by Andrea Casali have been cleaned, the valuable collection of birds put into good order and the various rooms redecorated. The famous geological collection, containing 27 teeth of *Microlestes moorei* and 70,000 fish teeth from fissures of Rhætic age in the Carboniferous Limestone, is being re-arranged and relabelled as a memorial of the labours of Charles Moore, who did so much for the Museum and for geology. The winter series of lectures interrupted by the War were recommenced in 1921-2, and have steadily increased in number and interest until the accommodation is insufficient. A project for widening the adjoining roadway may result in the present building being taken down, in which case it is to be hoped that the Society may find itself provided with sufficient funds and vigour for the provision of a more suitable and better-placed museum in which the collections can be better displayed.

THE May issue of the *Scientific American* inaugurates a discussion as to whether street accidents due to careless driving would be diminished by the substitution of a regulation as to the distance in which a vehicle should be able to stop for the present speed limit. Mr. H. W. Slauson, who opens the discussion, is of opinion that they would, and points out that the object of the speed limit is to ensure that

the driver shall have his vehicle under such control that he can stop quickly when called upon to do so. He may be under the speed limit, but his physical and mental condition and the state of his brakes may be such that he cannot stop quickly enough to avert an accident. Under the speed limit regulation he is blameless. The fault lies with the regulating authority. Under a stopping-distance regulation, the duty of adjusting the speed to the condition of the driver and his vehicle would rest on the driver. Roads would be specified as "twenty feet," "fifty feet," etc., and the tests of vehicles would be simpler than the present speed tests.

THE Report of the Castle Museum, Norwich, for 1924, records a large number of gifts, and among them a fine series of mounted heads and horns of big game bequeathed by the late Mr. E. N. Buxton. To accommodate these, as well as the many previously in the Museum, it is proposed to extend the building over a portion of the inner garden. It has also proved necessary to extend the Skin-Room over a vacant space enclosed by the outer wall of the Castle. A large collection of flint implements from various local sites, presented by Mr. H. H. Halls, has been drawn upon, with others, to provide a case illustrating neolithic culture in Norfolk and Suffolk. In many other directions, not so directly within our scope, this Report bears witness to a progress and activity of which Norwich should be proud.

SOCIETIES and Institutions in Great Britain, desiring to get into touch with similar bodies in Russia for the purpose of exchange or purchase of recent scientific publications, should address correspondence on the subject to one of the following organisations, in the hands of which the government of the U.S.S.R. has placed the responsibility for all arrangements of the kind. For all societies and institutions in Leningrad: The Publications Exchange Department, The Academy of Sciences, Leningrad. For all those in the whole of the rest of Russia, and for those in other constituent territories of the Union of Socialist Soviet Republics: The Book Exchange Bureau, The U.S.S.R. Society for Cultural Relations with Foreign Countries, Sverdlov Place, Moscow.

DR. C. A. CROMMELIN has published the inaugural lecture delivered by him on May 12 on the occasion of his taking up the post of lecturer in physics at the University of Leyden (Leyden. Edward Ijdo). As is well known, Dr. Crommelin has collaborated with Prof. Kamerlingh Onnes for many years in the conduct of the experimental researches carried out at the famous Physics Laboratory of Leyden. In all that relates to the science and art of measuring pressures, temperatures and volumes, he is one of the most experienced physicists in Europe, and now that Prof. Kamerlingh Onnes has retired, there is perhaps no one in the world who possesses the same knowledge of the intricate technique required in the measurements at low temperatures and high pressures which characterises so much of the work done at Leyden. In his address Dr. Crommelin has given a most interesting historical sketch of the development in the

making and using of instruments and apparatus in connexion with experimental research in physics. It is illustrated with portraits of three members of the celebrated van Musschenbroek family and is fully documented with literature references. For many years the laboratory of Kamerlingh Onnes has been a famous training school for young instrument makers and glass-blowers. Perhaps nowhere else in the world has so much attention been given to the development of this side of the work which is required in a great laboratory of experimental research in physics. It is therefore particularly appropriate that Dr. Crommelin should deal with this subject in his inaugural address, which can be heartily recommended to all who take an interest in the history of physical experimentation.

IN the Report of the Rhodesia Museum, Bulawayo, for 1924, the curator, Dr. G. Arnold, records the finding of several palaeoliths from an ancient land surface now covered by 15-20 feet of flood-silt from the Umgusa River. He believes "that these implements, mostly of a Chellean and Acheulian facies, were fashioned by the predecessors and contemporaries of Broken Hill Man."

APPLICATIONS are invited for the following appointments, on or before the dates mentioned. A part-time research demonstrator in mathematics at Uni-

versity College, Swansea—The Registrar, University College, Singleton Park, Swansea (July 15) Museum assistant and demonstrator in zoology at Birkbeck College—The Secretary, Birkbeck College, Fetter Lane, E.C.4 (July 21). Professor of electrotechnics in University of the Witwatersrand, Johannesburg—Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (July 31). Five appointments in the School of Dental Surgery, Cairo, namely, superintendent and lecturer in metallurgy and materia medica, lecturer in surgery and pathology, assistant lecturer in surgery and pathology, lecturer in mechanics and orthodontia, and a mechanic—The Under-Secretary of State, Ministry of Education, Cairo (August 14) Professor of organic chemistry and director of the chemistry department, Armstrong College, Newcastle-upon-Tyne—The Registrar (August 15) Director of the Rubber Research Institute in the Malay States—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, Westminster, S.W.1 (August 31). A reader in biology in the University of Hongkong—The Chief Medical Officer, Ministry of Health, Whitehall, S.W.1 (September 1). Professor of public health in the University of Edinburgh—The Secretary (September 15) Laboratory assistant for the Mobile Unit, Government Laboratory, Gold Coast—Crown Agents for the Colonies, 4 Millbank, Westminster, S.W.1.

Our Astronomical Column.

DISCOVERY OF A TENTH MAGNITUDE OBJECT—A telegram from the International Astronomical Union Bureau, Copenhagen, announces the discovery of an object of the tenth magnitude. Its position on June 28 at 1^h 37^m 0^s G.M.T. (new) was R.A. 0^h 23^m 28^s, N. Decl. 0° 41'. Daily motion +1^m 48^s, N. 14'. The motion is rather large for a minor planet, unless it should be of the Eros type.

M. Delporte apparently took the plate in the search for Tempel-Swift's periodic comet, using the ephemeris in the British Astronomical Association Handbook. However, as a later examination makes the probable date of perihelion March 1926 (see B.A.A. Journ., vol. 35, p. 159), the object is not likely to be identical with that comet. No further observations are to hand at the time of writing.

THE ROYAL OBSERVATORY, GREENWICH.—Dr. J. L. E. Dreyer contributes an article to the *Nineteenth Century* for July, which summarises the work done at Greenwich during the 250 years of its existence, and emphasises the vagueness of the knowledge of the heavens that existed at the time of its foundation. Tycho Brahe's star catalogue was then the best available, and the best lunar tables differed a quarter of a degree or more from the heavens. Flamsteed's observations of the moon were of great assistance to Newton for comparison with his gravitational theory. Dr. Dreyer vindicates Flamsteed against the charge of withholding these observations from Newton.

The splendid work of Bradley is given due prominence, credit being also given to Bessel and Auwers, who brought the results into a form that later astronomers could utilise. The development of the work of the Observatory under Airy and the further extensions made since his time are also described.

Dr. Dreyer is well known as an astronomical historian, and he has a congenial subject in dealing with the remarkable advance in knowledge since

1675, in which Greenwich has played a considerable part.

THE PHYSICAL STATE OF THE STARS—While insisting on the incompleteness of the available observational material, Dr. A. Brill, in the *Zeitschrift für Physik* of March 21, attempts to deduce, on the basis of the Eddington theory, general regularities in the connexion between spectral type, surface temperature as deduced from colour and from energy distribution in the spectrum, absolute brightness, mass and other physical magnitudes for a very large number of dwarf and giant stars. It was found that the logarithm of K , Eddington's constant, which determines the mass absorption coefficient k in the interior of a star, only varies from 27.41 to 27.69 between the different spectral classes. k/ϵ is nearly constant for all stars, where ϵ is the energy radiated in unit time per gram. The following table, abridged from that in the original paper, gives some of the results obtained. Super giants are not considered.

DWARFS						
Spectral Class	Temp °C	M(vis)	R cm	Mass gm.	$\frac{k}{\epsilon}$ sec ⁻¹	ρ gm/cm ³
O	28.7 × 10 ³	-4.00	711 × 10 ⁸	738 × 10 ³¹	9.70 × 10 ²	4.9 × 10 ⁻⁸
B ₀	21.4 "	-1.30	241 "	154 "	17.7 "	2.6 × 10 ⁻⁷
A ₀	11.8 "	+0.90	170 "	54.7 "	12.6 "	2.7 × 10 ⁻⁷
F ₀	7.76 "	+2.65	143 "	32.2 "	10.5 "	2.7 × 10 ⁻⁷
G ₀	6.32 "	+4.50	90.8 "	21.3 "	17.2 "	6.8 × 10 ⁻⁸
K ₀	5.23 "	+6.35	59.7 "	15.1 "	28.1 "	1.7 "
M ₀	3.79 "	+11.00	19.2 "	6.89 "	124 "	23 "
GIANTS						
G ₃	4.98 "	+0.25	1150 "	79.1 "	0.399 "	1.2 × 10 ⁻⁸
K ₃	4.57 "	+1.55	824 "	56.0 "	0.348 "	2.4 × 10 ⁻⁸
K ₅	3.62 "	+0.75	2550 "	99.5 "	0.102 "	1.4 × 10 ⁻⁸
M ₅	3.52 "	+0.25	3250 "	112 "	0.0757 "	8.7 × 10 ⁻⁹

M(vis) is the visual absolute brightness in magnitudes, R the radius, g the gravitational acceleration at the surface, and ρ the density.

Research Items.

THE ETHNOLOGY OF THE FINNO-UGRIANS.—Dr. U. T. Sirelius has published through the Government Printing Office, Helsingfors, a study of the history, culture, linguistic and physical characters of the Finno-Ugrian peoples under the title "The Genealogy of the Finns." Although it is clear from the concluding chapter, which advocates political independence for those members of the group who have not already attained it, that the pamphlet is a piece of political propaganda, it is nevertheless a useful review of the evidence bearing upon Finno-Ugrian affinities and early history. No comprehensive survey of the physical characters of the Finno-Ugrians has been made, but such available data as are comparable indicate considerable divergence and show that they are no longer even approximately a homogeneous race. They fall into two main groups, one short, comprising Lapps, Ostyaks, and Voguls, all living near the Polar Circle, and a tall group to which belong all the other peoples, Hungarians, Baltic Finns, Volga Finns, and Permians. The Samoyeds, whose linguistic kinship to the Finns is now clear, resemble the members of the former group. In culture also there is a division between the Lapps, the Seryemans of Archangel, the Voguls and Ostyaks, belonging to the north, who live by hunting, fishing, or reindeer breeding, and the remainder, who are tillers of the soil.

PERFORMANCE TESTS OF INTELLIGENCE.—Report No. 31 of the Industrial Fatigue Research Board, prepared by Miss Frances Gaw, describes performance tests of intelligence. Most of the well-known intelligence tests have a decided bias towards linguistic ability, and although for many activities of life language is a necessary medium, yet in dealing with some types, e.g. the deaf, the blind, it is necessary to find some other way of measuring intelligence. In the United States, owing to the large population of non-English-speaking foreigners, the study of performance tests has aroused much more interest than in England. This report discusses the need for them, their historical development, the principal scales and uses, and describes a series of performance tests. A comparison of these tests with other estimates of intelligence and with tests of mechanical and constructive ability is given, and there is a useful bibliography. All those interested in intelligence testing will find these tests a useful supplement to the usual ones, and particularly valuable in the case of those children who tend to express themselves in other than linguistic modes.

JAPANESE ALGÆ AND FUNGI.—Dr. Hans Molisch, professor of plant physiology in the University of Vienna, has been travelling for a considerable time in Japan, and Volume 1, No. 2, of the Science Reports of the Tôhoku Imperial University (Fourth Series), Biology, is composed entirely of various notes contributed by him upon his observations whilst in Japan. Dr. Molisch finds the same organism, *Bacterium phosphoreum* (Cohn), responsible for the development of luminosity in butcher's meat in Japan, if this flesh is kept standing in 3 per cent. sodium chloride solution, but not submerged in the solution. He describes curious fusiform bodies in a Japanese species of *Vaucheria*, which from their reactions appeared to be protein in nature. He records the occurrence of a parasitic Alga, *Mycoides parasitica* Cunningham, upon leaves of *Camellia*, and of an epiphyllous Alga, *Phycopeltis epiphyton* Millardet, upon the leaves of various evergreens in Japan. *Pseudoplasmodium auranthacum* Molisch is described and figured as the

species of a new genus of Acrasieæ. Various fungi are described with the habit of growing in and feeding upon the waxy deposits on the cuticles of many species of grasses, of *Acer*, and of other trees. Some of these fungi were also grown in culture on beeswax. Prof. Molisch also supplies considerable data upon various organisms responsible for the deposition of hydrated oxides of iron in Japan, a subject on which he has already published a monograph based upon his European studies. He also records *Nostoc* colonies living apparently in symbiosis with two different liverworts, *Blasia pusilla*, L., and *Cavicularia densa*, St.

EFFECT OF THYROID FEEDING ON FOWL PLUMAGE.—Torrey and Horning (1922) reported that when dried thyroid was given to growing males these assumed hen-feathering. Crew and Huxley (1923), repeating this work, but with different material and methods, failed to obtain confirmatory results. However, it was noticed during the course of this work that the administration of thyroid was followed by a marked increase in the rate of plumage growth and replacement, and that in the birds used, Rhode Island Red (red ground with black areas) and Light Sussex (white ground with black areas), the birds receiving thyroid exhibited a pronounced tendency towards increased melanism, the black areas being markedly increased in size and intensity at the expense of the other colours. Since it is known that such a parti-coloured bird tends to become lighter as it ages, the suggestion presents itself that in senility the thyroid of the fowl becomes relatively less efficient in its functioning. Moreover, the observation that thyroid administration increased the rate of feathering in the growing chick and moulting adult gained in significance when Serebrowsky (1922), and more recently Warren (1925), showed that quick feathering as contrasted with slow is a typical sex-linked character. One who seeks to interpret genetic action in terms physiological is attracted by the notion that this sex-linked factor in its action determines the time during development when first the thyroid comes into action or the degree of the functioning of this gland. Cole and Reid (*Journ. Agric. Res.*, 29, 6, 285-287, 1924) also have recently repeated the work of Torrey and Horning and have obtained results which show beyond all doubt that thyroid administration does indeed affect the plumage characters of the male. They found that new feathers grown by the birds receiving desiccated thyroid showed distinct modification towards the female type of structure and colour and that the rate of growth of these new feathers was noticeably increased. There was a reduction of red pigment, the distribution of which was irregular, and also a reduction of that area of the feather in which the barbs lack barbules, the feathers of the hackle regions, instead of being pointed and elongate, coming to possess broad rounded ends closely resembling the feathers of these regions in the female.

THE GEOGRAPHICAL RANGE OF THE JURASSIC CRINOID PENTACRINUS.—The imperfection of the geological record is a conception that should constantly be applied to the distribution of extinct creatures no less than to their range in time. Many genera of crinoids, long known from only one country or one quarter of the globe, have of late been found to have a far wider, sometimes indeed a world-wide, distribution. *Uintacrinus*, *Marsupites*, and *Saccocoma* have yielded instances. These, it happens, are all

unstalked forms and if, as some suppose, they were members of the plankton, then their wide distribution is readily explained. The latest case, however, is that of a very much-stalked form. The species *Pentacrinus subangularis*, recorded from the Middle and Upper Liass of Europe, has now been found in Alaska. Dr Frank Springer (Proc. U.S. National Museum, 67, Art. 5) also regards as very close relations some columnals previously known from Dakota and Utah and some lately described by himself from Roti in the Dutch East Indies. This range, he says, far exceeds that of any crinoid of the present ocean. "The deep and clear seas prevailing in the Jurassic and Cretaceous periods were," he thinks, "favourable to the development and spread of marine faunas over large areas with a minimum of checks and interference, in contrast to those of subsequent periods down to the present, in which owing to the great changes in land form affecting the conditions of marine life, and to increasing competition arising from the multiplication of forms, the tendency has been toward progressively greater restriction of faunal areas." This may be, but in this connexion one may recall the many specimens of *Pentacrinus fossilis* attached to logs of wood, and may surmise that *P. subangularis* also belonged to the pseudo-plankton in its young stages. In spite of its wide distribution and its great abundance of individuals, the genus *Pentacrinus* did not, so far as we know, survive into Cretaceous times.

THE RANGE OF OTHER FOSSIL CRINOIDS.—Another instance of a wider distribution than had been supposed is afforded by the genus *Apiocrinus*. This crinoid, of which the Bradford or pear encrinite is the best-known example, is not uncommon in the Jurassic rocks of Europe, but has not hitherto been recorded from America. In the Proceedings of the United States National Museum (vol 67, Art. 18, 1925) Dr. Frank Springer now describes some columnals from rocks, probably of Upper Jurassic age, on the isthmus of Tehuantepec, Mexico, and refers them to this genus as a new species, *A. tehuantepec*. It is also a genus long known only from Europe; at least it was not generally recognised that the Cretaceous form of it was represented in New Zealand. Recently, species of this form have been identified from various other regions of the Western Hemisphere, so that it rivals *Pentacrinus* in its distribution although so much later in time. This does not quite substantiate the contrast drawn by Dr. Springer. It is still unsafe to base conclusions upon our ignorance. For example, the fossil comatulids, of which so many species are known from Europe, appear as yet to be represented in America only by the rather obscure *Microcrinus* of Emmons; no doubt they also will be found

SEISMIC WAVES.—The March issue of the *Journal de Physique* contains the results of the observations of the earth and air waves produced by the destruction of melinite on four dates in May 1924 at the camp of La Courtine in the centre of France. The earth waves were observed by MM. C. Maurain, L. Eble and H. Labrousse by the aid of seismographs recording the vertical, horizontal transverse and horizontal longitudinal movements of the ground at three stations between 5.5 and 25 kilometres from the point of explosion. The waves most rapidly propagated affect the vertical and longitudinal instruments only and travel with a mean speed of 5.52 kilometres per second; the slower or long waves affect all three instruments and travel with a mean speed of 2.80 kilometres per second. At the station nearest to the explosion a further slight transverse wave of speed 4 kilometres per second was observed. At Meudon,

340 kilometres from La Courtine, MM. A. Perot and F. Baldet observed the arrival of the air wave by means of a drum closed by a paper diaphragm and a sensitive flame, and found the mean speed of propagation to be 341.7 metres per second at 16° C., the first effect being a decrease of pressure of 0.6 millimetres of mercury followed by an equal increase.

THE NILE AND ITS FLOODS.—In "A Short Account of the Nile and its Basin," Dr. H. E. Hurst has published a paper he read to the International Congress of Geography (Cairo, 1925), which contains a useful summary of the latest data, accompanied by a large scale map, with regard to the Nile floods. The Nile water supply comes from two sources, first the tributaries rising in Abyssinia, and secondly, the water from the Lake Plateau of East Africa. Very little water from the Sudan reaches the Nile, since it is largely evaporated where it falls. During September, when the water is highest in the main Nile, the Blue Nile contributes 72 per cent., the Atbara 15 per cent., and the White Nile 13 per cent. During the low stage of the main Nile the White Nile supplies 80 per cent. of the water. The White Nile is at its maximum discharge in October, its waters having been held back from July to September by the rapid rise of the Blue Nile. The White Nile water comes from two sources, the Sobat and the Bahr el Gebel and Bahr el Zeraf. Very little is known of the details of the regime of the Sobat, but its maximum discharge is in October and November, while the maximum of the Abyssinian tributaries is in September. The Bahr el Ghazal, in spite of its large basin with a good rainfall, contributes very little water to the Nile. Practically all the discharge of the Gebel and Zeraf comes from the Great Lakes and the plateau, but fully half that enters the swamps of the Gebel is lost. The regime of the lakes is not well known.

SURFACE DAY VISIBILITY.—The Meteorological Office, Air Ministry, in Prof. Notes, Vol. 3, No. 40 (H.M. Stationery Office, Price 3d.), has issued a discussion on the ground day visibility at Cranwell, Lincolnshire, during the period April 1, 1920–December 31, 1923, by Mr. W. H. Pick. The relationship dealt with is that existing between ground visibility and the surface wind direction, the surface wind velocity, the existing pressure type, and the presence or absence of convection currents. For the Cranwell area it is concluded that bad or poor visibility is most frequent with wind calm or from about south-east, while good or very good visibility is most frequent with winds from north-eastward or southward. Winds with a greater velocity than 15 m./hr. are seldom accompanied by bad or poor day visibility. Days with convection, taken as days with cumulus or cumulo-nimbus cloud, are likely to be accompanied by good or very good visibility. It is regrettable that, when referring to weather types, numerals only are given, being those affixed by Col. Gold in his "Aids to Forecasting," Geophysical Memoirs, Vol. 11, No. 16. The communication in this respect is comparatively valueless unless the reader has the M.O. publication referred to. In a discussion on similar lines, Prof. Notes, Vol. 3, No. 37, noticed in NATURE, December 6, 1924, p. 838, dealing with pressure type in relation to fog frequency at Scilly during summer months, specimens were given of the different types of weather with which the author was concerned; economy in printing has possibly caused the omission.

A WIDE-ANGLE (180°) LENS.—A compound lens that enables one to photograph the entire inner surface of a hemisphere at one exposure is described by Mr. Conrad Beck in an article in the

Journal of Scientific Instruments, vol 2, No 4, 1925. The principle of the method occurred to Mr W. N. Bond and to Mr Robin Hill independently, and is that of the view which is obtained of the sky from under water, the "fish's view". Mr Hill has devised the apparatus, which consists of a large front lens of $2\frac{1}{4}$ inches diameter, with a curved convex outer surface. At this surface a view angle of 180° is contracted to a cone of about 90° . The inside surface of this lens is very deeply concave, and of such a curve that the central ray from each point of the view passes through it with scarcely any deviation. Close to the apex of the light-cone thus formed is a comparatively small photographic lens. The combination gives an image of the complete hemisphere on a flat disc about $2\frac{1}{4}$ inches diameter, and with an aperture of $f/22$ good definition is obtained over the whole area. The character of the distortion of the image is described, and an undistorted image of any part of the photograph is obtained by reversing the action of the apparatus so that the lens is used to produce the projected image. The description is illustrated by 5 photographs of the sky, one of the nave of Ely Cathedral, and enlargements from a part of the last and one of the skies. The enlargement of the Cathedral clearly demonstrates the elimination of the distortion.

X-RAY ANALYSIS OF SOLID NITROUS OXIDE AND CARBON DIOXIDE—It is noteworthy that the Laboratory of Physics and Physical Chemistry of the Veterinary College at Utrecht, in which van't Hoff held his first appointment at the time when he enunciated his new theory of "Chemistry in Space," is now producing, under the direction of Prof N. H. Kolkmeijer, an important series of investigations of space-structure by the modern method of X-ray analysis. It was natural that one of the first cases studied in a laboratory so close to that of Prof. Cohen should have been that of white and grey tin, with the result that grey tin was shown by Kolkmeijer and Bijl in 1918 to have the familiar lattice-structure of the diamond. A more recent paper, reprinted from the Proceedings of the Amsterdam Academy, describes the crystal structure of solid nitrous oxide and carbon dioxide. Each substance has a cubic symmetry, the side of the cube containing four molecules of N_2O being $5.72 \text{ \AA}$, whilst that which contains four molecules of CO_2 is $5.63 \text{ \AA}$. The distance between two neighbouring atoms is given as $1.15 \text{ \AA}$ in N_2O and $1.05 \text{ \AA}$ in CO_2 . Another paper records the fact that black precipitated mercuric sulphide, although often described as "amorphous," crystallises in the cubic system and has a structure similar to that of the cubic form of zinc sulphide.

THE SPECTRA OF ISOTOPES.—In the issue of the *Physikalische Zeitschrift* for May 25, Dr G. Joos, of Jena, summarises the present state of our knowledge of the influence of isotopes on spectra. Up to now trustworthy evidence of such influence has only been furnished in the case of band spectra, in which both the oscillations and rotations of the nucleus are slowed down for the heavier isotopes, as, for example, in the well-known case of the hydrogen chloride doublets. In other cases the observed change of frequency has been used to determine the constitution of the nucleus the movements of which produce the spectral line, and the hydride of the metal concerned has frequently been found to be the effective material. So far, the influence of isotopes on line spectra has only been found in the case of lead, and it appears to be due to some difference of the structure of the nucleus. No direct connexion between

the satellites of spectral lines and the isotopes of the material appears to exist.

THE CONTINUOUS SPECTRA OF THE HALOGENS—After considering the different conditions under which the continuous spectra of iodine vapour and of bromine and chlorine are observed, Dr W. Steubing has come to the conclusion that they are not of molecular but of atomic origin, though they are not connected with the normal atomic line spectra of the elements (*Zeitschrift für Physik*, May 5). For the production of line spectra, accurately defined orbits with definite energy values are necessary, monochromatic emission will not occur when electron jumps take place which cannot be ascribed to a definite quantum orbit, but the emission will be governed by the laws of chance. It has been shown by the author that the outer electron layer, in the case of the halogens, is very unstable when acted on by magnetic and electric fields, and it is considered probable that it is also unstable for mechanical shocks, a single electron of a broken-up layer will, at first, have no uniquely defined energy, and will only attain this when the layer is completed. Thus the emission will not be monochromatic, but it will lie between certain limits having a definite boundary on the long wave-length side, as is actually observed in these three spectra. Other gases and vapours which emit a continuous spectrum do not exhibit a definite boundary towards the red.

HYDROGEN-NITROGEN AND LIQUID AMMONIA EQUILIBRIUM.—The volume percentages of ammonia in a compressed hydrogen-nitrogen mixture over liquid ammonia have been measured by A. T. Larson and C. A. Black, who record their results in the April issue of the *Journal of the American Chemical Society*. A true equilibrium appears to exist. The temperature interval used was -22.5° to 18° and the pressure range 50 to 1000 atm. The volume percentages increase with increasing temperature and decreasing pressure, the values are much higher than those calculated from the vapour pressure of liquid ammonia.

QUENCHED CARBON STEELS—A valuable little paper on "The Structure of Quenched Carbon Steels" was presented at the recent meeting of the Iron and Steel Institute by B. D. Enlund, of Sweden. He has carried out measurements in order to determine the influence of annealing on the electrical resistivity and the specific volume of quenched carbon steels. All the curves show two bends, one appearing at a temperature of $110-120^\circ \text{ C}$. and the other at about $250-260^\circ \text{ C}$, according as the carbon content of the steel is high or low. These bends are visible in all the curves, thus indicating that the same reactions occur in all the steels. The bends consist in all cases of deviations towards the temperature axis, which indicates that a precipitation of cementite takes place at the temperatures mentioned. As is well known, a reaction of this kind is always accompanied by an increase in electrical conductivity. From a knowledge of the phenomena occurring in high-carbon steels quenched from a high temperature, it may thus be concluded that the break in the curves at about 110° is caused by the transformation of martensite into troostite, and the second by the resolution of austenite into α iron and cementite. Though very slight, the second bend in the curves of the mild steels is quite distinct, and it is thus evident that even such steels contain γ iron representing untransformed austenite. This is a very interesting and valuable conclusion to have established. The formation of troostite at 110° C is accompanied by a contraction, whereas the precipitation of α iron and cementite at 250° C . causes an expansion.

The National Physical Laboratory, Teddington.

ANNUAL VISITATION.

ON Tuesday, June 23, the annual visitation by the General Board of the National Physical Laboratory took place. In accordance with custom a number of members of scientific and technical societies and institutions, government departments and industrial organisations, were also invited to the Laboratory, which was open for inspection. The visitors were received in the new Aerodynamics Building by Sir Charles Sherrington, president of the Royal Society and chairman of the General Board, Sir Arthur Schuster, and the Director of the Laboratory, Sir Joseph Petavel. Prior to the visitation the new entrance to the Laboratory, in Queen's Road, was formally opened by Sir Charles Sherrington.

Referring to the general development of the Laboratory, Sir Charles remarked that it is now twenty-five years since the Laboratory came into being, and in that period it has come to occupy an all-important place in the national organisation for the advancement of science. This rapid growth is a testimony of the energy and ability of the first Director, Sir Richard Glazebrook. With the further expansion under his successor, Sir Joseph Petavel, arose the demand for new roadways. Their construction was begun in 1922, and the projected development included the improvement of the approaches to existing buildings and the reconstruction of the entrance from Queen's Road. It is gratifying that the new roads have been named Kelvin Avenue and Rayleigh Avenue. The service which the late Lord Rayleigh rendered to this institution cannot be overstated, and forms an abiding part of its high tradition.

An extensive series of exhibits had been arranged to illustrate the general character of the work of the Laboratory.

In one of the seven-foot wind channels in the Aerodynamics Department was a model for investigating the performance of the autogyro, a machine representing an innovation in aeroplane design. This machine differs from the orthodox type in that it has no wings, their place being taken by an airscrew on an axis which is nearly vertical. The machine is equipped with a motor and propeller as usual, and the motion of the air past the vertical screw as the machine gathers speed causes it to rotate and to lift the machine from the ground. It is claimed by the inventor of this machine (which is being developed in Spain) that an almost vertical landing is possible and that it will not stall.

In the four-foot wind channel was exhibited an apparatus for investigating rapid fluctuations of wind velocity, such as occur in the eddy region behind an obstacle placed in the channel. Owing to lag, ordinary anemometers cannot follow these variations, and the possibility of using hot wire anemometers for the purpose is being explored. A hot platinum wire forms one arm of a Wheatstone's bridge, and changes in wind velocity affect its resistance, disturbing the balance of the bridge. The corresponding variations in the current are shown by an Einthoven galvanometer. With the finest platinum wire one-thousandth of an inch in diameter, fluctuations of 2 or 3 per second are faithfully recorded.

In the Engineering Department an interesting exhibit was an instrument for recording the vibrations of structures. In this an arm carrying a small stylus is so pivoted on a frame that it responds to very minute vibrations of the frame. Supported by means of springs is a system possessing large inertia com-

pared with the vibrating portion and carrying a smoked glass plate, on which the vibrations of the stylus are recorded. The stylus magnifies the vibrations twenty times, and a further magnification of fifty times is obtained by optical projection. A testing machine for big-end bearings of petrol engines was also shown. This work has been undertaken in connexion with the development of high-power lightweight internal combustion engines.

Other exhibits included apparatus for investigating the impact strength of chains and for examining the stress set up in pipe sockets due to caulking. In this connexion it has been shown that for some time after caulking there is a definite slow reduction in caulking stress, indicated by a gradual reduction of the outside diameter of the socket.

The Department of Metallurgy and Chemistry displayed specimens of light alloys which had been treated for the removal of occluded gases. One of the defects of aluminium alloy cast in sand is "pinholing" due to the presence of these gases, the degree of occlusion of which is affected by the rate of solidification. If the alloy is cast in a metal mould, solidification is rapid and the gases are retained in solution.

There were also shown examples of the pure metals manganese, chromium, and iron, prepared in the Laboratory. Pure iron and chromium are produced by electrolysis from an aqueous solution of their salts. Pure manganese is prepared by distillation from the commercially pure mineral in a high-frequency induction furnace in vacuum, which is also used in the preparation of pure alloys of these materials. Special refractory crucibles made from pure magnesia and alumina were produced for this purpose. A further exhibit showed beryllium obtained by the electrolysis of fused beryllium salts. The metal has a high degree of purity and is produced by slowly withdrawing the cathode, thus forming a rod which is afterwards melted in the induction furnace already mentioned.

The Chemistry Section displayed apparatus for determining the viscosity of molten glass. The glass is contained in a platinum crucible in an electric furnace, and is withdrawn adhering to a fine platinum wire moving at a definite rate, the temperature of the furnace being observed with an optical pyrometer. The viscosity is obtained from the weight of glass adhering to the wire.

In the William Froude National Tank there was shown the apparatus for the investigation of the movements of a lifeboat on a slip-way during launching. As the boat traverses the slip-way, the progress of its bow and stern are recorded electrically after each fall of 6 inches. The conditions under which the tests are being conducted include varying slip declivity and friction, smooth and stormy water, and different states of the tide. An exhibit of popular interest was a wax model of H.M.S. *Victory*. This was ballasted and towed from the travelling carriage of the tank so as to simulate the course which a sailing ship would take under sail, and its leeway could be measured. The apparatus for determining the resistance and running angle of flying boat hulls in motion prior to taking off was also shown.

In the Metrology Department were a number of exhibits dealing with high precision measurements, and comprising standards and measurements of mass and length, measurements of volume, and the testing of hydrometers, barometers, and chronometers.

Another exhibit was a new form of cadmium lamp

recently invented by M. Hamy which contains no internal electrodes. It is stated that the spectrum from this is identical with that from the Michelson cadmium lamp, which in the past has been used for experiments on the use of a wave-length of light as a fundamental unit of length. The comparison of a 6-in. and a 36-in. Fabry-Perot étalon illustrated how, by stepping up, lengths of the order of a metre and over can be measured accurately in terms of the ultimate unit.

The apparatus for silvering the plates used in interferometry methods of measurement was shown. The glass plate forms the anode of a vacuum vessel, and the cathode, of silver, is hung above it. The silver film is deposited on to the plate by the passage of an electric discharge. Films from 1 to 2 millionths of an inch in thickness can be obtained by this method.

In the workshop was a machine for facilitating the accurate lapping of pivots. In this the work in progress is magnified by projection, and the operator can compare the magnified image with an outline drawing, on the same scale, of the required profile.

The Physics Department was responsible for a large number of exhibits. Among them was an apparatus for the determination of the effect of humidity on the mobility of ions. A heated platinum wire mounted in an insulated metal tube is used for the production of the ions, which are drawn to the outer tube by the application of an electric field, the thermionic current being measured in the usual manner by means of an electrometer. The experiments are conducted at atmospheric pressure, and the humidity of the air surrounding the heated filaments can be adjusted. Another interesting exhibit was an apparatus for the determination of the heat loss from bare pipes. A graphite rod extending from end to end of a long iron pipe is heated electrically and the energy dissipated in it is measured. The corresponding temperatures at various points along the pipe are measured by thermocouples.

In the Sound Section was an apparatus for the photographing of sound waves. The passage of an electric spark across a short gap produces a single spherical sound pulse, the shadow of which is afterwards photographed under the illumination of a second spark. By using this apparatus in conjunction with sectional models of buildings, the acoustic properties of the latter can be determined.

The purity of the sounds produced by electrical apparatus used in acoustical work depends upon the wave-form of the electrical oscillations. A cathode ray oscillograph for the study of the latter was shown, the spot describing a circle on the fluorescent screen when the oscillations are sinusoidal.

Among the exhibits of the Radiology Section were Laue photographs of diamonds used as pivot bearings. In this connexion it has been found that the direction of the cleavage plane of the diamond with reference to the bearing surface is of great importance.

In the Optics Section were shown a flicker photometer for heterochromatic photometry and a spectrophotometric equipment using unpolarised light. In

the latter, the absorbing optical parts are reduced to a minimum and measurements are made by a Lummer-Brodhun contrast field. As a result the instrument is very efficient at low illuminations. It possesses two collimators, and the light from the two sources is brought to approximate equality by means of rotating sector discs, the final balance being obtained by means of a wedge in the path of one of the beams.

In the Electrotechnics Department, Alternating Current Division, a recently constructed power-measuring apparatus was on view, including a precision electrostatic wattmeter. Another exhibit consisted of the calibration of a 10,000 kilowatt 3-phase wattmeter operating at 6600 volts. This calibration is carried out by the employment of a fictitious load method in which the pressure and current coils are separately excited. In the Direct Current Division was shown a 5000 volt direct current set, for tests on equipment connected with railway electrification. In particular, it has been used for the testing of impregnated timber designed to protect railway workers from shock through accidental contact with the live rail.

The exhibits of the Photometry Division included the apparatus for the standardisation of electric incandescent lamps in terms of the international candle and for the measurement of mean spherical candle power. In the experimental illumination building, demonstrations of the use of the daylight-factor meter—an instrument for the direct measurement of the proportions of the total external daylight reaching various points in a room—were in progress.

In the Wireless Division was an oscillograph used for analysing the wave-form of a valve oscillator and amplifier. A condenser in the grid circuit of an oscillator discharges linearly through a diode, and the discharge can be synchronised with the oscillations to be measured. The actual wave-form is traced out by the spot on the fluorescent screen of a cathode ray oscillograph. Another interesting feature was an apparatus for the measurement of the intensity of the field from a distant radio transmitting station.

A number of piezo-electric quartz resonators and oscillators for the purpose of radio frequency standardisation were shown in the Electrical Measurements and Standards Department. These oscillators form extremely constant sources of radio frequencies and are capable of controlling the output of valve generators. Another exhibit was a standard sonometer for the measurement of audio frequencies. The apparatus is very simple in principle. It consists of a phosphor-bronze wire loaded with a heavy weight. The wire passes between the poles of an electro-magnet and carries the current the frequency of which is under measurement. A sliding bridge with rack and pinion enables the free frequency of the wire to be brought into synchronism with that of the source. A pointer indicates the frequency directly. Various scales corresponding to modes of vibration in one, two, three, five, and ten loops, are used. The total range is from 100 to 10,000 cycles per second, with an accuracy throughout of 1 in 1000.

Glacier Lassitude.

ON the Mount Everest Expedition, 1924, a peculiar condition of prostration and lassitude was experienced by its members whilst crossing ice under certain conditions. The appearance of this fatigue was found to coincide with the presence of a hot sun and a still air: this combination of conditions led to a saturation of the stratum of air on the glacier with moisture, so that the loss of heat from the body was

interfered with. The effect was not due to altitude alone, since the lassitude disappeared the moment the observers left the glacier, and was not experienced in the early morning or late evening.

The explanation of this effect given by Major Hingston has been confirmed by some experiments undertaken by Leonard Hill and A. Campbell (*Lancet*, 1925, vol. i. p. 939). The authors examined the

effects of work with the bicycle ergometer in ordinary atmospheric air (21 per cent. oxygen) with a dry bulb temperature of 20° C. and a low cooling power, and with a temperature of about 8° C. and a high cooling power, and compared them with those produced by similar temperatures when the air breathed contained only 11-13 per cent of oxygen: this level of oxygen was sufficiently low to produce symptoms of deficiency of oxygen in the experimental subject, such as weakness, giddiness, and cyanosis. It was found that an atmosphere with a low cooling power, or one with a lowered oxygen content, increased the pulse-rate more than one with a higher cooling power or a normal oxygen content: the effect of cooling power was observed whether the atmosphere contained a low or a normal amount of oxygen, while the effect of variation in the oxygen supply was seen independently of the cooling power of the atmosphere. When the two more disadvantageous conditions were combined in one experiment, that is, a lowered percentage of oxygen in the air breathed together with a low cooling power of this atmosphere, the increase in the pulse-rate was about equal to the increase due to the anoxæmia plus that due to the low cooling power. In the two subjects examined, the increase due to these two factors combined was about 24 and 36 beats per minute respectively: and at the same time the symptoms of anoxæmia and discomfort were more marked under warm conditions with a low oxygen tension. It was also found that there was no hindrance to the passage of oxygen across the pulmonary epithelium when air with a low oxygen tension but saturated with moisture was breathed, so-

that the results observed appear to be due to the two factors of overheating of the body and of breathing oxygen at low tension. The pulse-rate alone is a guide to the distress of the heart under these conditions.

An obvious means of counteracting the effects of altitude is to increase the oxygen in the air breathed by a supply from some form of apparatus, but in the last expedition this method was found to be of little benefit. Hill and Campbell make the following suggestions to account for this finding. The observers have been in an atmosphere containing a low oxygen tension for a considerable time, and the effects of enriching this atmosphere with oxygen may be different from those observed in unacclimatised subjects submitted to acute anoxæmia for short periods. A further factor is the difficulty of obtaining the full amount of oxygen given by the apparatus, some being almost inevitably wasted, without the wearing of a face-piece. Finally, the authors lay stress on the oxygen dissolved in the plasma in distinction from that in combination with the hæmoglobin in the corpuscles. It is of course the dissolved gas which is immediately available for the tissues, and the amount of this depends on the tension of the gas in the alveoli of the lung. Breathing air containing 30 per cent. oxygen at 29,000 feet would give only about 60 mm. mercury tension of this gas in the alveolar air. Although this would saturate the hæmoglobin to 90 per cent., the amount of gas dissolved in the plasma would be only about two-thirds of that normally present when ordinary atmospheric air is breathed, so that the supply available for the tissues would still be distinctly subnormal.

The Middle Carboniferous of the North of England.

MR. W. S. BISAT'S paper on "The Carboniferous Goniatices of the North of England and their Zones" (Proc. Yorks. Geol. Soc., N.S. vol. 20, 1924, pp. 40-124 and Pl. I.-X.) must take rank as one of the classics of Carboniferous stratigraphy. It provides the first clear guide to the "no man's land" of grits and shales which lie between the Carboniferous Limestone and the coal measures, while it will also be of the greatest value in the correlation of the Coal Measures themselves by providing a sure base from which to work.

The Goniaticite succession is traced from the upper Viséan to the base of the Upper Coal Measures (of Lancs. and Yorks.). Zones D3 and P (the latter characterised by *Goniaticites s.s.*) are retained in the Viséan. They are represented by the "knoll" limestones and the Bowland shales, which are regarded as in part contemporaneous. For the overlying beds, up to and including part of the Lower Coal Measures, the term Lancastrian is introduced. These beds are divided into the zones of *Eumorphoceras* (E), *Homoceras* (H), *Reticuloceras* (R) and *Gastrioceras* (G) in ascending order. Hinde's Pendleside group (=Bowland shales) is found to be substantially equivalent to the Yoredales in age, and it is therefore proposed to discard the term, retaining Bowland shales as a facies name. The group belongs partly to P (Viséan) and partly to E (Lancastrian). The Yoredales of Derbyshire belong mainly to a higher horizon (upper E and H), corresponding to the Sabden shales of the Pendle area, while the overlying Kinderscout grit and shale is referred to R, leaving the upper portion of zone R together with zone G for the higher grits and part of the Lower Coal Measures. The major (generic) zones named above are divided into minor (species) zones, of which twenty-one are recognised. Local details of the zonal determinations are given somewhat fully

for south Yorkshire and Lancashire, with more brief reference to other areas.

The value of the stratigraphical portion of the paper is dependent on the full study of Goniaticite palæontology on which it is based, and which forms the second (and larger) section. This constitutes a monograph on the family and one only regrets that it is not in more definitely monographic form. In its present relations, it is naturally concerned mainly with the diagnostic characters of species and varieties, and has less emphasis on their mutual relations and general evolution, though the section commences with an excellent key to the genera. The ontogenetic history is found to be strikingly uniform throughout the family, especially in regard to sutures, but with the usual independence in the rate of development of the several characters. Fifteen genera (four new) and fifty-six species (thirteen new) are described. The largest number belong to the zones D, P, E, and H, below the Kinderscout grit. Above that horizon only *Reticuloceras* (in the grits) and *Gastrioceras* (in the upper grits and Lower Coal Measures) appear to occur. A noteworthy feature is that the sutural development is at its maximum in the earliest zones, the species which follow being evidently katagenetic in this respect. The history of the other characters is less obvious, but the striking reduction in the number of species and the variability of the later forms seem to confirm a general decadence of the family. All those interested in Carboniferous stratigraphy will look forward with the highest interest to the further extension of Mr. Bisat's work.

The same part of the Yorkshire Geological Society's Proceedings contains a valuable résumé by Mr. G. W. Lamplugh of our present knowledge of the Speeton clays (the presidential address) as well as other important contributions.

Societies and Academies.

LONDON.

Optical Society, May 14.—F. W. Preston: (1) The fundamental law of annealing. The fundamental law of annealing, that the rate of decrease of stress varies as the square of the stress present, is deduced from first principles by means of dimensional analysis, assuming that the rate of decrease of stress depends, (1) only on the stress present and the viscosity; (2) on the stress present, the viscosity, and the rigidity of the material. The law suggested as an empirical relation by Adams and Williamson is true dimensionally.—(2) The dimensional accuracy of Mr. Hampton's paper on "The Annealing of Glass." No corrections are made in Mr. Hampton's results, which are based on sound reasoning. The practical conclusions of Mr. Hampton's paper are justified in every way.—T. Smith: Note on the cosine law. Objections raised to the statement that rays selected by a cosine relation determine caustic surfaces in the object and image spaces, and to some points in the proof of the cosine law, are considered, and the adoption of the original enunciation of the theorem justified as opposed to the modified form suggested by Hertzberger and approved by Boegehold. A direct derivation of the analytical form of the law of refraction from the cosine law is given.

Royal Statistical Society, May 19.—Sir Napier Shaw: Week or month as an intermediate time-unit for statistics. In agriculture the week is generally recognised, but the month often exerts a certain dominance; in finance the year is the chief unit and next to that the week; for meteorology the calendar month is dominant and the week is only used at present for special purposes such as correlation with agriculture or hygiene; for railway statistics the calendar month and year again are dominant; for social statistics (Poor Law, etc.), the week is the favourite unit; for trade and shipping the month is used exclusively, whereas the week and corresponding quarters are the bases of vital statistics in the majority of countries; Brazil, Bulgaria, Hungary and Italy, however, use the month for that purpose. Starting from the conclusions: (1) that the original purpose of the month to keep in touch with the phases of the moon has not been successful, (2) that the division of the year into twelve unequal parts is not a fundamental principle of statistical science, (3) that a period shorter than a month is necessary for various reasons of correlation, and (4) that there is no possibility of using monthly data in connexion with weekly data or vice versa; a suggestion is put forward for placing statistical data upon a basis of weeks or groups of weeks with an adjustment to the calendar year. The grouping of the fifty-two weeks of the year into thirteen groups of four weeks each, or four groups of thirteen weeks each, is left open. For general climatic purposes a quarterly arrangement with judicious selection of the quarters might be sufficient.

Geological Society, May 20.—H. Dewey: Palæolithic implements of Chellean type found in the gravel of Hyde Park, London. The implements were collected from gravel thrown out of a deep trench of length 44 feet, breadth 14 feet, depth 40 feet. The London clay has been exposed at the northern end of the excavation, but falls suddenly at the southern end to an unknown depth. The gravel therefore covers a step-like fracture, which curves round from west and east to north-east. The stones are principally Chalk-flints. The implements

were all from a depth of 26 feet. They include one hand-axe of Chellean type; the topmost portion of a second hand-axe; two choppers worked along the edges so as to provide a comfortable hold, two long flakes or flake-scrapers; a broad flake or grattoir; and some pieces showing a certain amount of human workmanship.—J. W. Tutcher and A. E. Trueman: The Liassic rocks of the Radstock District (Somerset). These rocks are unusually interesting, because in some divisions they are very thin, the total thickness of Lias does not exceed 200 feet, and is often much less. The succession of rocks has been worked out. An unusual number of ammonite faunas are richly represented, often in remanié deposits. Deposition of White Lias occurred during a time of fairly uniform subsidence, and was followed by folding along east-and-west axes, and denudations of the anticlinal areas. Deposition was renewed and followed by uplift in the south and denudation of much of the clay there. Then came deposition of the Obtusum nodule-bed and of the Raricostatum clay, and afterwards renewed uplift in the south and denudation. Further deposition included the Armatum bed in the south only, a remanié bed; the Jamesoni limestone, fairly uniformly; and the Striatum and Capricornum clays.

EDINBURGH

Royal Society, May 25.—John Thomson: Parasitism of *Cuscuta reflexa* (Roxb.). The hyphæ or modified root-hairs are differentiated into strands of tracheids when they meet the xylem vessels of the host. Those which enter the host phloem are not modified; moreover, the shaft of the haustorium contains no sieve-tubes. The irritation set up by the entry of the haustorium stimulates all the living cells in the neighbourhood of the haustorium to active cell-division. In woody host stems the general result is to increase the radius of the stem of the host on the side invaded by the parasite. Connexion with the host xylem is maintained by the differentiation into tracheids of young parenchyma cells at the tip of the haustorium. Experiments in growing the parasite on peeled stems demonstrate that the plant can live on the materials derived from its host's wood, even when its chlorophyll is prevented from functioning by enclosure in a light-tight box. The haustoria formed in such circumstances are perfectly normal except that their size is less. These facts suggest that a plant's xylem is capable of transporting plastic materials as well as water with mineral salts in solution.—C. W. Wardlaw: Size in relation to internal morphology: No. 2, The vascular system of *Selaginella*. The xylem is in the form of a thin ribbon, an arrangement which makes for a large surface of interchange with living tissue. With increase in size the xylem band widens out. Where the vascular system is of large size, the broad stelar ribbon must be broken up in order to be adequately disposed in the stem. Such species are polystelic, with three to five stelar ribbons, and measurements show that a constant ratio exists between the width of the median stele and the diameter of the stem. The polystelic species have been regarded as derivative and specialised types. From the foregoing argument, however, it follows that polystely is not necessarily a derivative condition in the phyletic sense, but is a modification in form consequent on increase in size. Hence the isolated position of those species which show polystely in Baker's systematic arrangement need not be held as destructive of the validity of that classification.—S. Williams: Some points in the anatomy of *Dicksonia*. *D. antarctica* and *squarrosa*

possess dictyosteles not far removed from solenostely. In both the stele appears in transverse section as a curiously corrugated cylinder due to the oblique passage of the leaf traces through the cortex. Inwardly projecting flanges are present in both species at the margins of the leaf gaps. From a study of the anatomy of the above large stems and of a number of other examples, it is concluded that increase in size of the stele in the vast majority of ferns has been accompanied by (a) adaptations to increase the surface of interchange between the stele and the surrounding tissues, and (b) modifications of the xylem mass to ensure constant contact between the tracheids and living parenchymatous elements.—A. E. Trueman and Miss Daisy Williams: Studies in ammonites of the family Echioceratidae. The paper deals with those ammonites from the Lower Lias which were formerly referred to *Echioceras varicosatum*. In creating several genera and in describing the species, considerable attention has been paid to the evidence obtained from the study of the ammonite sutures and from the shell development. Discussing relationships and descent, it is shown that the development of an ammonite shell frequently tends to follow the most direct line from the embryo to the adult form, and that this ideal ontogeny may be achieved by the skipping of ancestral stages which do not fall on the direct line or which do not fit the embryo for its particular environment.

PARIS.

Academy of Sciences, June 8.—L. Lecornu: The phenomenon of refraction. A discussion of the condition which must be fulfilled by a force acting on a material point so that its velocity on change of medium may vary as predicted by the wave theory. Jules Andrade: Concerning a theorem of metrology: elastic clocks and spiral balances.—Tzitzéica: Certain skew curves.—M. Soubbotine: The law of errors of observation.—Lawrence M. Graves: Taylor's theorem in general analysis.—D. Pompeiu: The monogeneity of functions of one complex variable.—P. Noguès: The invention of the cinematograph. During the period from 1882 to 1890, Marey realised the fundamental arrangement which constitutes what is now called the cinematograph.—L. Ollat: The resonance of coupled circuits.—J. Cayrel: Detection with galena. With a single isolated sensitive crystal, only the (111) faces have given rise to normal intense detection. The (100) faces, on the contrary, show a very feeble detection, nearly always inverted and often unstable. With insensitive crystals the (111) and (100) faces behave similarly: both show inversion.—E. Bodin: The peculiarities presented by radiation cells of great electrical resistance.—G. Ribaud: High frequency induction electric furnaces for the production of very high temperatures. A description of the construction of an induction furnace open at two ends and permitting the attainment of a temperature of 2500° C.—G. Reboul: A new mode of production of slow cathode rays.—La Rosa: The velocity of light and its dependence on the movement of the source of light. Reply to a communication by M. Salet.—Léon and Eugène Bloch: The spark spectra of chlorine. An extension of the method of analysis of spark spectra given by the authors in an earlier communication and its application to the analysis of the spark spectra of chlorine.—Pierre Auger and Francis Perrin: Theoretical considerations on the directions of emission of the photo-electrons.—Pierre Brun: The miscibility of mixtures of water, ethyl alcohol, and isobutyl alcohol. The results of the experiments are given in the form of graphs.—

Georges Denigès: A new method of diagnosis and of immediate determination of cobalt by spectroscopy and chromoscopy. The blue colour given by cobalt compounds with hydrochloric acid has a specific absorption spectrum: the reaction detects 0.02 milligram per cubic centimetre of solution. The method is of service in the detection and estimation of traces of cobalt in commercial nickel and its salts.—Maurice Nicloux: The determination of carbon monoxide by the blood method and some remarks on the absorption of this gas by hæmoglobin in the absence of oxygen. Details of the technique of the method, which is shown to be capable of detecting carbon monoxide in the proportion of 3 parts per million.—M. Bourguet: The hydrogenation of the triple link. The formation of *cis*-ethylenic compounds. Using colloidal palladium as the catalytic agent, the reduction with hydrogen at the ordinary temperature of various acetylene derivatives has always given the *cis*-ethylene compound. This is in accord with the geometrical representation ordinarily adopted for the double and triple linkages in acetylene and ethylene derivatives.—Max and Michel Polonovski: The aminoxides of the alkaloids of the tropane group.—R. Locquin and R. Heilmann: New trimethylenic bases: the ureas of the pyrazolines.—E. E. Blaise and Mlle M. Montagne: The acyclic δ -diketones. Transformation into pyridine derivatives. The action of hydroxylamine upon the δ -diketones constitutes a general method for the preparation of pyridine bases.—R. Bourret: The geology of the region of Pak Lay (Middle Laos).—L. Duparc: Some curious lode-bearing rocks in the neighbourhood of Mestigmer (Morocco).—E. Vander Linden: A case of striking by lightning.—Marcel Mirande: The phytosterol of the scales of bulbs in the species of the genus *Lilium*.—C. Charaux and P. Delauney: The presence of loriglossine in *Listera ovata* and *Epipactis palustris* and on some new reactions of this glucoside.—R. de Litardière: The phenomenon of cytomixis in the microsporocytes of *Podophyllum peltatum*.—Ladislav Smolik: The exchange of the aluminium ion of soils of different types against the potassium ion of a neutral salt.—Antonin Nemec: The hydrogen-ion concentration in the tissue of seeds. The experiments recorded show that the hydrogen ion concentration in the seed tissues indicates, at least approximately, the value for the reaction of the medium favourable to the development of the plants arising from the seeds.—Auguste Lumière and Rémi Courjon: The influence of the time of coagulation of the blood on the toxicity of sera.—L. M. Betances: The genesis of the blood platelets.—H. Chatellier and H. P. Chatellier: The embryological evolution of the endolymphatic outlet in man.—E. Aubel and J. Salabartan: The significance of the decomposition products formed by the coli bacillus at the expense of glucose.—P. Lasareff: The statistical theory of the adaptation of the eye in the course of peripheral vision.—Ch. Porcher: The action of carbonic acid on the calcium caseinates. Introduction to the study of colloidal calcium carbonate.—P. Cappe de Baillon: The general characters of double monsters in phasmids.—J. Beauverie: Does the bacterial symplasm exist? The case of *Azobacter*. After an extended period of cultivation of *Azobacter chroococcum*, it has not been found possible to prove the existence of a regenerative symplasm which was not the result of a degenerescence, of a contamination, or of an erroneous interpretation. The author regards the formation of a bacterial symplasm as unproven.—Charles Kayser and Mlle Eliane Le Breton: The regulating mechanism of purin metabolism: diabetes.—Paillot: The cytological

alterations in the course of the evolution of the disease of the nucleus of the larvæ of *Pteris Brassicae*.

CAPE TOWN.

Royal Society of South Africa, April 15.—H. Spencer Jones: Notes on solar parallax. A good determination of this constant is important for establishing a base-line on which our knowledge of the dimensions of the visible universe is founded. The methods of its determination may be divided into three classes: (1) The observation of the apparent displacements of a planet like Mars or Eros against one or more stars viewed from two points differently situated in relation to the centre of the earth; (2) determinations of the orbital velocity of the earth compared with the velocity of light; (3) observations of occultations of stars by the moon, from which the perturbing influence of the sun on the moon's orbit can be ascertained. The best determinations of the solar parallax from these three independent methods lead to almost identical results, namely, $8''.805$ with a probable error $\pm 0''.002$.—Louis P. Bosman: Some observations on aconitine: Aconitine ($C_{34}H_{47}NO_{11}$) on oxidation yields oxonitine $C_{24}H_{31}NO_9$. It is known to contain three (CH_3O) groups, one (CH_3CO) group, one (C_6H_5CO) group, and one $N \cdot CH_3$ group. There seems to be an inner anhydride of a dicarboxylic acid.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 11, No. 4, April).—T. Y. Thomas: On the projective and equi-projective geometries of paths.—O. Veblen and J. M. Thomas: Projective normal co-ordinates for the geometry of paths. They are independent of the components of affine connexion appearing in the differential equations of the paths. Equations of paths through the origin are linear.—J. M. Thomas: Note on the projective geometry of paths. Projective tensors other than the Weyl curvature tensor can be derived.—W. Hovgaard: Determination of the stresses in a beam by means of the principle of least work. No *a priori* assumptions are made as in Saint-Venant's method.—M. T. Bogert and C. N. Andersen: Researches on selenium organic compounds. V. A simple method for the synthesis of 2-substituted benzoselenazoles.—Alice H. Armstrong, W. Duane, and R. J. Havighurst: The reflection of X-rays by alkali halide crystals. Using a potassium iodide crystal and reflecting X-rays from the 100 planes gave a double image and a series of fine lines, due apparently to minute crystals with their axes parallel to that of the main crystal. This habit of crystal growth is suggested as the cause of the abnormal reflections obtained with the alkali halides.—I. I. Rabinov: Note on the diffraction of X-rays by a wedge-shaped slit. A fringe was obtained using the K_α line of molybdenum. Calculated width of slit, 0.0013 – 0.0018 mm.—D. L. Webster and P. A. Ross: The Compton effect with hard X-rays.—E. O. Salant: The heat capacity of solid aliphatic crystals. Many assumptions are made, but equations are derived from which results fairly in accord with experiment can be computed.—G. P. Baxter and H. W. Starkweather: The density and atomic weight of helium. Three 1-litre globes were used, as in the determination of the density of oxygen (NATURE, March 28, p. 483). Average density of helium, 0.17845 . Using the density found above for oxygen, namely, 1.42901 , and assuming that helium obeys Boyle's Law for the range 0.1 atmosphere, the atomic weight of helium, for various values of $(PV)_0/(PV)_1$ of oxygen, varies from 3.9995 to 4.0000 .

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Diary of Societies.

TUESDAY, JULY 14.

SOCIETY OF CHEMICAL INDUSTRY (Annual Meeting) (at Leeds), at 11 A.M.—Presentation of the society's medal to W. F. Reid.—Presidential Address: Dyestuffs.—In evening.—Prince G. Conti: How the Tuscan Boric Acid is made (Lecture).
CONVENTION OF ENGLISH-SPEAKING OPHTHALMOLOGICAL SOCIETIES (at University College) (also on July 15, 16, 17)

WEDNESDAY, JULY 15.

SOCIETY OF CHEMICAL INDUSTRY (Annual Meeting) (at Leeds), at 9.30 A.M.—Symposium on Coking Practice; Chairman, Prof. J. W. Cobb.—Dr. R. Lessing: The Influence of Ash Constituents on the Coking Process.—R. A. Mott and R. Wigginton: The Heating of Coke Ovens.—C. P. Finn: The Disposal of Coke Oven Gas for Public Supply.—W. H. Hoffer: A Comparison of Different Solid Adsorbents proposed for Benzole Recovery.
INTERNATIONAL CONFERENCE OF WOMEN IN SCIENCE, INDUSTRY, AND COMMERCE (at British Empire Exhibition, Wembley), at 11 A.M.—Opening of the Conference by the President, H.R.H. the Duchess of York.—Speakers: Viscountess Rhonda: Commerce.—Miss Ellen Wilkinson: Industrial Organisation.—Prof. Winifred Cullis: Science.
EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—Dr. J. A. Mjoe: The Analysis of the Component Faculties of Musical Ability and their Inheritance (Lecture).

THURSDAY, JULY 16.

SOCIETY OF CHEMICAL INDUSTRY (Annual Meeting) (at Leeds), at 9.30 A.M.—Symposium on Smokeless Fuel.—Dr. C. H. Lander and Dr. Margaret Fishenden: Smokeless Fuel—the Present Position and Future Possibilities.—E. C. Evans: Solid Smokeless Fuels: their Production, Properties, and Use.—F. S. Sinnatt and J. G. King: A Study of the Tars and Oils obtained from Coal.
INTERNATIONAL CONFERENCE OF WOMEN IN SCIENCE, INDUSTRY, AND COMMERCE (at British Empire Exhibition, Wembley), at 10.30 A.M.—Engineering, Chemistry, and Research:—Miss H. M. Davis: Electricity applied to Mining.—Miss Isabel H. Hadfield: Some Chemical Problems in the Cotton Industry.—Miss Ethel Bailey: Automotive Research.—At 2.30.—Industrial Welfare and Factory Inspection.—Miss Constance Smith: The Woman Factory Inspector in Industrial History.—Miss O. U. Kerr: The Effect of Welfare Work on Health and Efficiency.—Miss E. E. Wilson: The Possibilities of Advancement for Women in Industry.

FRIDAY, JULY 17.

INSTITUTION OF CHEMICAL ENGINEERS (Annual Meeting) (in Philosophical Hall, Leeds), at 9 A.M.—At 9.30 A.M. (Joint Meeting with the American Institute of Chemical Engineers).—Presidential Addresses by the President of the American Institute, Dr. C. L. Reese, and the President of the British Institution, Sir Arthur Duckham.—At 10.30 A.M.—Symposium on Industrial Water Supply and Stream Pollution.—F. P. Veitch and L. C. Benedict: Wool Scouring Waste Liquors, Composition and Disposal.—Dr. T. L. Bailey: Effluents from Ammonia Plants and their Disposal.—R. D. Littlefield: Distillery Waste Liquids and their Purification.—E. B. Besseltre: Statutory Regulation of Stream Pollution and the Common Law.—Dr. E. B. Higgings and J. P. O'Callaghan: The Preparation and Comparative Performance of Base-Exchange Materials in Water Softening.—Dr. T. P. Hilditch: Recent Experience of Doucil in Water Softening.—H. C. Parker: Electrolytic Conductivity and Hydrogen Ion Control.—S. L. Tyler: The Absorption of Hydrochloric Acid and Some Data regarding the Tyler-Vitreous System.—W. L. Stevenson: The State versus Industry, or The State with Industry.—J. W. Sale: Pioneer Studies by the Bureau of Chemistry on Pollution of Shellfish Areas.

INTERNATIONAL CONFERENCE OF WOMEN IN SCIENCE, INDUSTRY, AND COMMERCE (at British Empire Exhibition, Wembley), at 10.30 A.M.—Commerce and Salesmanship:—Miss G. Burlton: Salesmanship.—Miss J. F. Nettlefold: The Place of the Wholesaler in the Scheme of Distribution.—At 2.30.—Electricity—Domestic Science:—Miss M. Partridge: Producing and Distributing Electricity.—Miss T. J. Dillon: At Home with Electricity.

SATURDAY, JULY 18.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (at Town Hall, Folkestone), at 11 A.M.—A. E. Nichols: Municipal Works at Folkestone.—E. C. Fawcett: Folkestone's New Sea Outfall Works.

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Evolution and Intellectual Freedom.

THE agitation in the United States over the teaching of evolution is attracting such widespread interest that it has been proposed to build a stadium to accommodate twenty thousand people for the trial of J. T. Scopes, a Tennessee High School science teacher, for having taught the truth of evolution in defiance of the State law. The trial is to open on July 10. The charge of the judge to the grand jury began by reading the first chapter of Genesis as the account of creation which Tennessee teachers must adopt. He pointed out that part of the value of education is mental discipline, and that flagrant defiance of the law by the school authorities would not be a wholesome influence in the State. He insisted that the integrity of the law must be upheld. The main issue, however, will be decided by the Federal Court in its decision as to the right of a State to prohibit the teaching of fundamental philosophical principles.

The defence of evolution has been undertaken by the American Association for the Advancement of Science, which has appointed a committee of three distinguished biologists, Prof. E. G. Conklin, professor of biology at Princeton, Dr. C. B. Davenport, director of the Station for Experimental Evolution, Carnegie Institution of Washington, and Dr. H. F. Osborn, president of the trustees of the American Museum of Natural History, New York, to prepare a resolution upon the subject. The resolution, which has been adopted by the Council of the Association, is as follows:

"(1) The council of the association affirms that, so far as the scientific evidences of the evolution of plants and animals and man are concerned, there is no ground whatever for the assertion that these evidences constitute a 'mere guess.' No scientific generalization is more strongly supported by thoroughly tested evidence than is that of organic evolution.

(2) The council of the association affirms that the evidences in favor of the evolution of man are sufficient to convince every scientist of note in the world, and that these evidences are increasing in number and importance every year.

(3) The council of the association also affirms that the theory of evolution is one of the most potent of the great influences for good that have thus far entered into human experience; it has promoted the progress of knowledge, it has fostered unprejudiced inquiry, and it has served as an invaluable aid in humanity's search for truth in many fields.

(4) The council of the association is convinced that any legislation attempting to limit the teaching of any scientific doctrine so well established and so widely accepted by specialists as is the doctrine of evolution would be a profound mistake, which could not fail to injure and retard the advancement of knowledge and of human welfare by denying the freedom of teaching and inquiry which is essential to all progress."

The American Medical Association has expressed itself similarly in a resolution, passed by its House of Delegates, on the question of the teaching of evolution, "that any restrictions of the proper study of scientific fact in regularly established scientific institutions be considered inimical to the progress of science and to the public welfare."

The American Association is being helped in preparing a defence by the Science League, which was founded last year in San Francisco in order to secure liberty of teaching in American education.

These organisations have to meet a widespread and well-organised attack. The teaching of evolution has already been prohibited by law in Oklahoma and Tennessee. Bills for the same purpose were submitted to the State legislatures in Kentucky and in Texas and were rejected by the Upper House, in Kentucky by a majority of one vote. In Florida the legislature passed a resolution advising the educational authorities not to employ those who teach Darwinism, and the agitation for direct prohibition is still maintained. In North and South Carolina legislative action against the teaching of evolution was defeated, but text-books and teachers who favour evolution are debarred from the State schools. Georgia has as yet no absolute legislation on the subject, but the State Education Committee last July advised the legislature to refuse grants to any school, college, or university that favoured the doctrine of evolution, and it has recently withheld a grant from a State library because it contains books on evolution. Bills against the teaching of evolution are being introduced or have been introduced into the legislatures of the States of Arizona, Arkansas, Georgia, Illinois, Indiana, Iowa, Minnesota, Mississippi, North Dakota, Oregon, and West Virginia.

In California the effort was made, as mentioned in NATURE of May 9, p. 683, to avert a struggle by reference of the question to a committee of the nine

presidents of the State universities and leading colleges. Six of these colleges are under denominational control, and the unsatisfactory compromise previously referred to in NATURE has not satisfied either side. A requisition is being signed for a reference of the question to a ballot at the next election; and the Fundamentalists are said to be confident that they will carry the State, unless books which give even a moderate approval of evolution are excluded from the schools.

The anti-evolution party is being supported to some extent by the publishers. Thus, one distinguished New York biologist has been requested by his publisher to omit any reference to evolution in any new editions of his text-book, owing to the objections of the Southern and Western States. The intellectual terrorism in some of the States may be judged by the fact that according to the *Boston Evening Transcript* of May 23, although, while the anti-evolution Bill was before the legislature in Tennessee, many clergy protested against the proposed infringement of freedom of opinion, "there was never a word of protest from the State University." The North-eastern States show by the comments of the Press their deep regret at this outbreak of intellectual obscurantism, and it is to be hoped that an authoritative expression of opinion there may help the Southern and Western States to realise the heavy handicap they would be laying upon themselves, as well as upon their universities and schools, by the legal prohibition of well-established scientific principles.

In Great Britain, State interference with university teaching would not be tolerated. The proper body to decide what may or may not be taught in a university is the Senate or Council, and not a popularly elected civic chamber of any kind. It must not be forgotten, however, that education authorities in England exercise the right of control over the teaching of religious doctrine in schools, and that they could apply the same powers to the teaching of evolution if they wished. It is not for us, therefore, to attempt to justify what seems to have been a breach of law in the State of Tennessee, however much we may deplore that a State should pass a measure which is contrary to all modern ideas of progressive thought and intellectual freedom. What we are concerned with is the principle by which a political party or organisation should be able to put obstacles in the way of human enlightenment and independent thought, and should have the power of approving, or preventing, the teaching of scientific facts or conclusions of any kind. We have long passed the stage at which this was possible in England, and cannot help being astonished, therefore, that there should be States in

the United States of America which deliberately adopt a policy of scientific stagnation.

In order to ascertain the views of leading authorities in the fields of university work, science and religious teaching, upon this attitude, advance proofs of this article have been sent to a number of representative men, whose comments, here subjoined, will, we believe, be read with interest on both sides of the Atlantic.

Prof. WM. ADAMS BROWN, Ph.D., D.D.,
Roosevelt Professor of Systematic Theology, Union
Theological Seminary, New York.

My friend, Prof. Wildon Carr, has suggested to me that it might interest readers of NATURE to learn the views of an American observer as to some of the antecedents of the singular case presently to be tried in Tennessee. The incident, dramatic as it is, is not an isolated event, but part of a movement the beginnings of which go back many years, and has already caused a serious rift in several of the more important denominations; it cannot be understood without reference to its larger setting.

The first factor to be borne in mind is geographical. The United States, in spite of its hundred and ten millions of people, is still, judged by European standards, sparsely settled, and within its ample borders includes populations separated from one another by differences of antecedents, habits, and tastes, scarcely less marked than those which separate the different countries of Europe. There are wide areas of the United States in which the inhabitants know as little of what goes on along the Atlantic seaboard as the inhabitants of China or India. To understand the psychology of Fundamentalism, one must see such a play as "Sun-up," and remember that it truthfully describes the mental attitude of hundreds of thousands of American citizens of the purest English stock.

A second factor to be reckoned with is the tendency of Americans to standardise their thinking. This characteristic, which constantly surprises the English visitor, accustomed to the free expression of individual opinion on every topic under the sun, has its explanation, if not its justification, in the exceptional conditions under which the American democracy has developed its national life. With a people recruited from every quarter of the globe, living under conditions which stimulate individual initiative, there was grave danger that the unity of the national life might be lost unless the variant elements could be held in check by a powerful public opinion. In Great Britain, centuries of tradition have fixed habits of action in certain definite grooves, and one can safely allow himself the luxury of freedom in his thinking.

In the United States, where tradition is at a discount, and each man does what the need of the moment seems to require, there must be some steadying and conservative influence, and this, apart from the written constitution, is supplied by a powerful and often tyrannous public opinion. What is going on in religion in the so-called Fundamentalist movement has its parallels in economics and in politics. Feeling is often substituted for reason, and the nonconformist is punished by social disapproval, if not ostracism.

To understand the theological antecedents of Fundamentalism one must go back a generation to the Briggs case, the celebrated heresy trial of the last decade of the last century, which in so many ways paralleled the Robertson Smith case in Scotland. There, as here, the issue was the inerrancy of the Scripture; there, as here, the first result was the condemnation of the accused; but, at this point, the parallel ceases. In Scotland, the result was a revival of Biblical study carried into the homes of the people by a generation of ministers who were teachers as well as preachers—a revival which familiarised the rank and file of the people with the issues involved, robbed criticism of its terrors, and prepared the way for the saner and more scientific theology of to-day. In the United States, this result followed with certain individuals and in certain sections of the country, but for the most part the effect was different. The Briggs case shook the faith of many a minister in the old theology without giving him a firm grasp on the new. He therefore ceased preaching theology altogether and turned to social service or some other practical interest as a substitute. The result is that the present issue comes upon a people unprepared to meet it, and easily swept away by the plausible rhetoric of an orator like Mr. Bryan, who has learned by long practice to make words do duty for ideas.

It must be further recognised that when their real interest is separated from the fantastic opinions with which they have associated it, the Fundamentalists are contending for something with which men of a very different mental outlook may feel sympathy, namely, a positive and constructive Gospel. In the general loosening of old ties which has been the aftermath of the War not a few self-styled liberals have been ready to break completely with the past, and lightly to surrender values painfully won by the labour and sacrifices of many generations. The spectacle of this light-hearted radicalism has seriously alarmed many who would have been ready to respond to a saner presentation of the newer views, and, yielding all too readily to the psychology of the crowd, they have allowed themselves to lend their support to positions which, under less trying conditions, they would be the

first to repudiate. It is not the first time in the history of religion that a good cause has been discredited by the agents of which it has made use.

One further point requires brief notice. In spite of the factors I have mentioned, the controversy would not have reached its present acute stage if there had not been on the Fundamentalist side a systematic popular campaign, amply financed, which has carried the cry of the Gospel in danger into every section of the country. Only recently have the advocates of a reasonable Christianity realised the danger which confronted them, and organised for a similar campaign of education on the other side. That realisation has, however, come at last and that organisation been effected, and unless the American people have been permanently bereft of the good sense which has hitherto characterised them in critical hours, we may confidently expect that the forces of reaction will be checked, and a reasonable liberty of thought be safeguarded.

Sir RAY LANKESTER, K.C.B., F.R.S.

Formerly Director of the Natural History Departments of the British Museum.

IN the article about to be published in NATURE which you have sent to me for comment, I do not find any definite information as to the law or laws said to be operative in certain States of the American Union by which the teaching of the doctrine of evolution is forbidden, nor do I find any precise statement of the power said to be exercised by certain States of withholding pecuniary support or, on the other hand, of giving it to colleges or schools which teach or do not teach subjects approved or disapproved by the State legislature. One must suppose that such *direct* control of the educational programme of colleges and schools supported by grants from the public purse is approved by the citizens who elect the legislative body. If the wishes of the constituency are carried out, lookers on may regret or disagree with the programme enacted, but must admit that the action is in accordance with the fundamental principles of self-government. If the action is not in accordance with the wishes of a majority of the constituency, that majority can elect new representatives pledged to the policy it prefers.

Another very important question is raised in your article about which I have no information. You say that the Federal Court has the power "to decide as to the right of a State to prohibit the teaching of fundamental philosophical principles." One would wish to hear more about this power of the Federal Court, and also as to the interpretation of the term "fundamental philosophical principles." In the absence of information on these matters it would be rash to pursue the

subject further. Clearly enough (in my opinion) the integrity of the law must be upheld. The "law" can be altered by a regular constitutional method, but there seems to be no justification for disobeying it instead of repealing it.

The normal and healthy result of the exclusion from State colleges of "studies" which many citizens desire to be made accessible for themselves and their young people, must be to bring about a "boycot" of the State institutions in question, and the endowment of free "nonconformist" colleges to take their place. In many respects educational enterprise flourishes best, when free from State interference, State prejudice, State ignorance, and State jobbery. The great universities of the United States are independent corporations, and so are Oxford and Cambridge and their colleges, and so too are the other great universities of Britain. The State government does not at the present day presume to control their programme of studies, but rather protects them from fanatical influences and secures them in the possession of property which enables them to pursue the making and the diffusion of knowledge with independence and self-respect. The present freedom of student and professor and the self-governing status of "Universities" in Great Britain is the outcome of long and historical struggle. That status is not theoretically complete even now, but is in a reasonable state of adjustment to the demands of healthy progress. The university is expected in Great Britain to be (and *is*) tolerant of divergent opinions. It unites learned men of various philosophical outlook in a common effort to increase knowledge and to promote its diffusion through all classes of the community.

It must be incredible to British teachers that a judge charges a grand jury by reading out the first chapter of Genesis and declaring that that is the account of creation which Tennessee teachers must adopt. As a matter of *fact* that is *not* what the judge said. What he said was that, according to the law of the State of Tennessee, a teacher could not legally be paid his salary unless he taught the first chapter of Genesis as true. A Tennessee high school science teacher refused to give that teaching, and so has gained an enormous journalistic advertisement.

The whole affair is being worked by journalistic enterprise in the States on a misleading basis. There is no "trial" of the advertised teacher. He is no martyr. He is simply a case of the very ordinary failure of an employee who will not carry out the terms of his engagement and is dismissed accordingly. He is under no compulsion. He can teach according to contract or he can go elsewhere. He prefers to go. The interesting questions which remain for solution are: (1) Do the

free and independent citizens of the State of Tennessee approve of the action of their legislature in regard to the first chapter of Genesis? (2) Will the Federal Court over-ride the interference of the State legislature in this special instance? It will take time to educate the citizens of Tennessee so as to enable them to judge whether their legislature is wise or foolish in endeavouring to exclude the teaching of the doctrine of evolution from State-supported colleges. We must wait and see. But in the meanwhile the great colleges of Harvard, Yale, and Princeton and the scientific academies and museums of the United States are not affected by this storm in a tea-cup.

P.S.—I should like to place on record the fact that at Oxford in 1873 I gave, as deputy of the Linacre professor of anatomy and physiology, a course of public lectures on "The Genealogy of the Animal Kingdom," in which I fully accepted and taught Darwin's doctrine of descent. Neither at Oxford nor afterwards when I gave a similar course of lectures at the Royal Institution in London was there the smallest protest or objection raised to the straightforward teaching of the doctrine of evolution and Darwinian zoology. On the contrary, I received warm encouragement alike from professors and undergraduate students.

Prof. E. W. MACBRIDE, D.Sc., F.R.S.,
Professor of Zoology, Imperial College of Science
and Technology, South Kensington.

THE remarkable movement in America aiming at the suppression of the teaching of evolution in schools and universities is too widespread and has far too much momentum behind it to be accounted for as a mere outbreak of intellectual obscurantism. The general public there, as elsewhere, is profoundly uninterested in scientific speculation, unless this is discovered to have a practical bearing on life. It is because, in the opinion of the average American, the doctrine of evolution as taught in American schools and colleges is liable to defeat the purpose for which those institutions were established that he has risen in revolt against it.

The Fundamentalist argument is as follows:—These schools and colleges from which we desire to exclude evolutionary teaching were established by men brought up in the Puritan tradition, which has largely moulded and developed the American national character, of which we are all proud. The object for which these homes of learning were founded was not the imparting of abstract truth but the training of men to be good citizens. Evolutionary teaching in America has led to a purely materialistic and mechanistic view of life: it teaches that individual men are mere ephemeral bubbles on the surface of things: that their moral ideas are only tribal taboos of no particular validity: that "conscience and

free-will," to quote a leading exponent of "behaviourism," "are mistakes of the older psychology," that "God" and "Heaven," according to another evolutionary philosopher, "are defence-mechanisms different in degree but not in kind from the illusions of the paranoiac," and the widespread acceptance of such ideas would undermine the American character.

The most practical objection to the Fundamentalist position is its entire futility. Nothing could do more to stimulate widespread interest in evolutionary views than the attempt to prohibit them. The American youth in particular resents being forbidden any of the fruits of the tree of knowledge, and the attempt to do so will only whet his appetite for them. Just as hundreds of boys and maidens now indulge in whisky drinking who in pre-prohibition days never dreamt of such a thing, so it is to be anticipated that hundreds of youth who previously were entirely satisfied with cinemas and baseball will become evolutionists.

The only way effectively to combat the mechanistic view is to build up a thorough and convincing idealistic criticism of it. This is the path which has been followed in England; indeed few if any of the great Victorian scientists were blind to the enormous intellectual difficulties involved in a thoroughgoing materialism: for this reason Huxley, amongst others, wisely adopted the position which he termed "agnosticism"—freely acknowledging that problems of the relation of mind to body were entirely beyond the competence of science to solve. Since Huxley's day, idealistic criticism has grown in strength, and so it has come about in Great Britain that all sorts and conditions of men, including reverend bishops of the Church and nonconformist divines, accept evolution, whilst still refusing to accept a mechanistic view of life and the universe. We commend the consideration of these facts to Fundamentalists in America.

Sir ARTHUR SHIPLEY, G.B.E., F.R.S.,
Master of Christ's College, Cambridge.

THE average American of the Middle and Southern States is a very naïve mammal. As a "prominent citizen" tells us in the current number of *The National Review*, the United States is a nation of adult children, and certainly some of the things they do seem to older and more mature countries decidedly childish. The farmers and the Methodist and Baptist pastors of States like Tennessee, Kentucky, Oklahoma, are really convinced that they can make a people moral and religious by enacting laws. But the laws in America are so seldom enforced. Before the War some eight or nine States passed a law by which all lunatics and criminals were to be sterilised, but I

believe the law has only been observed in one or two cases. Seven years ago I was sitting next to a very vinegary lady at Des Moines in Iowa. She was jubilant over the Volstead Amendment, and said they would now tackle tobacco, and as soon as they had got that noxious weed out of the way, they would have a world campaign against the drinking of tea or coffee, both of which she understood contained poisons. She closely cross-examined me as to whether the students at Cambridge were allowed to smoke, and when I told her that they were, and that I hoped they did, because we believed in the freedom of the individual, she became almost abusive. But finally I silenced her by saying that she seemed so devoted to liberty that she wanted to take it away from everybody else in order to add to her own store.

Now, in several States there is an attempt to control free thought. In the Churches, America has scarcely passed beyond the region of the Presbyterian prosecution of Robertson Smith nearly fifty years ago. They have heresy-hunts, again an attack on free thought. The Ku Klux Klan movement is largely directed against certain forms of religious faith. They are

"Fightin' like devils for conciliation,
An' hatin' each other for the love of God."

But all the laws they pass can be and are evaded, and one has no doubt that in those States that have forbidden the teaching of evolution, evolution will still be taught. Unfortunately, as a whole the people of these "sections" are not a reading people, and seldom soar above a light illustrated magazine, or they would read what they may not be taught. The new text-book with which the Tennessee text-book commission has replaced the one used by Mr. J. T. Scopes states, "In reference to all animals resembling man, none of them are to be thought of as a source of origin of the human species." But, after all, thought is free, in spite of Mr. William Jennings Bryan, if one likes to think that man descended from animals resembling man, it will be very difficult to stop it.

Of course, there is a great deal of money in these proceedings. It will be the making of Dayton, where nothing has ever happened before and there is doubtless an expensive publicity agent with an itching palm. The average European who has not seen it has no idea of the "lobbying" carried on by the more pushing publishers in the United States to get their books adopted. Text-books are remunerative, and whoever has got the contract for these new biology books will probably make a very good thing out of it. In the days of Henry Newell Martin, if he wrote a "Physiology" which was to be adopted as a school book by any State, he had to append a chapter on the

dangers of alcohol, otherwise it had no chance of being accepted. As Kipling says of the American :

Enslaved, illogical, elate,
He greets th' embarrassed Gods, nor fears
To shake the iron hand of fate
Or match with Destiny for Beers.

Of course, now it does not pay to make beer in America, you must substitute synthetic gin for the last word of the couplet, but unfortunately synthetic gin does not scan.

The Right Rev. E. W. BARNES, D.D., Sc.D., F.R.S.,
Lord Bishop of Birmingham.

THE ignorant fanaticism which has led to the prescription of evolution in certain Western States of America is deplorable. As one who values intellectual freedom I am shocked that Anglo-Saxon communities should seek by legislation and prosecution to prevent the spread of knowledge. As a Christian I am dismayed by a movement which opposes a reasonable formulation of the Christian Faith. Cumulative and well-tested evidence has convinced every reputable biological expert throughout the civilised world that man has evolved from an ape-like stock. The normal educated Christian in Great Britain regards the process of evolution as the machinery by which God has created man. Every divine of any eminence among us accepts this point of view. Such acceptance strengthens the Christian position, for it makes the spiritual interpretation of the universe which we derive from Christ more convincingly reasonable.

No part of the teaching of Jesus, as set out in the New Testament, can by the most ingenious sophistry be held to imply belief in the literal truth of the Genesis account of creation. The "Fundamentalists," forget that the Bible is a spiritual treasure-house, not a scientific manual. They ignore the Christian doctrine that the Holy Spirit is still at work among men, leading them to an ever fuller understanding of truth ; with a fear that is really anti-Christian, they assume that a fuller knowledge of truth will weaken rather than establish the Christian revelation. The inevitable result of their attempt to repudiate sound science in the name of religion will be that tens of thousands of college boys and girls in America will repudiate Christianity in the mistaken belief that it is bound up with pitiable ignorance.

In England the battle was fought out more than a generation ago. From the blind religious prejudice of men like Pusey, Samuel Wilberforce, and Gladstone (why do political leaders damage their fame by theological obscurantism ?) we were mainly saved by the enlightened boldness of the Victorian liberal divines ; of Archbishop Temple ; of Frederick Denison Maurice,

who was never tired of quoting the spirit of Darwin's investigations as a lesson and a model for churchmen ; of his friend Kingsley ; of Bradley, the Dean who buried Darwin in Westminster Abbey ; of Farrar, who preached his funeral sermon ; of Canon Wilson, who still survives in honourable old age. But without such men the truth would have prevailed. It will prevail in the long run in the United States. Of what avail was it that the Roman church placed heliocentric treatises on the Index of Prohibited Books ? The earth moves : and the mind of man moves also to embrace an evergrowing understanding of the mystery of creation.

Prof. W. J. SOLLAS, Sc.D., F.R.S.,
Professor of Geology, University of Oxford.

THE action of the State of Tennessee raises a number of questions which it would be interesting to discuss were it not that they are all subsidiary to the one which agitates the minds of all freedom-loving peoples, *i.e.* the right of the State to suppress the teaching of scientific truths. On the subject of evolution there is, I believe, among competent thinkers but one opinion. To put it in a form that will be readily understood by our Puritan friends, all zoologists and botanists are agreed that the creation of species, including man, proceeds or has proceeded by way of evolution. This a theory which might almost be regarded as a fact ; it is so widely and surely based that it might be ranked as of equal certainty as the revolution of the earth around the sun, a subject which supplies an interesting parallel with the present one if only we substitute Papists for Puritans.

But all endeavours to suppress a truth are as futile as they are false. If natural history is to be taught at all in the schools, then in the end the truth will out. The structure, functions, habits, and distribution of animals and plants are, it is true, subjects of such absorbing interest that lessons upon them, from which all theory is carefully filtered off, are sufficiently attractive in themselves to arrest the attention and engage the studies of a class, but the interrelation of the facts they disclose must inevitably suggest many searching inquiries, and curiosity once aroused will not rest satisfied until it has received an answer. Then, if we are really back in the days of the Inquisition, the next step which will devolve upon the State will be the institution of an Index Expurgatorius. Short of this the truth will no longer rest concealed.

We reach, then, a stage when the community will arrive at a knowledge of the facts of evolution. Then comes the question—What about its explanation ? There we are on very different grounds. It is no secret that Darwin's explanation no longer occupies

undisputed possession of the field, and there are without doubt many distinguished investigators who freely admit that a satisfactory explanation has yet to be found. For myself, I confess that I regard the Darwinian explanation as only a half truth, and I think that the discussion of this question requires wider knowledge and greater maturity of judgment than the schools are likely to provide. It should be left to the universities, and even then the implications of all evolutionary theories should be carefully borne in mind, for the effects of some of them, if rashly introduced into ethics, personal, social, or political, might prove to be disastrous in the extreme.

Sir ARTHUR KEITH, M.D., F.R.S.,
Hunterian Professor and Conservator of Museum,
Royal College of Surgeons of England.

It is in no spirit of levity that I, a life-long student of the human body, would quote here, for the benefit of Fundamentalists, both at home and abroad, a saying of that Master whose teaching they claim to follow: "Father, forgive them, for they know not what they do." For if their desires are fulfilled, the teaching of anatomy will become a colossal system of organised hypocrisy. In every sentence of his lecture, a professional anatomist, who is compelled to base his teaching on the first chapter of Genesis, must sin against the truth which is in him. If the teaching of evolution is proscribed, then the study of the development of the human body must be forbidden by law, for in its development the human body proclaims that evolution is true. Dissection will have to be forbidden; for every one, be he teacher or student, who dissects man's body and compares it with that of apes and of monkeys, has the same truth forced on his perception.

Only penal servitude for life will keep men from searching the records of the rocks and discovering that the earth itself has kept a detailed history of plant, beast, and man, and all of these records shout aloud that evolution is true. All the fossil remains of primitive man, of beings who are almost as much ape as man, will have to be destroyed and all written description of them obliterated if Darwinism is to be undone. The stone implements of ancient man, which have been gathered with such meticulous care from recent pages of the earth's history, will have to be gathered together and solemnly carried to the deepest sea and there sunk. For these silent witnesses carry the history of man and the history of woman tens of thousands of years beyond the days of Adam.

Archæologists must be forbidden to enter Egypt and Mesopotamia, for they are carrying history further back than the Bible allows. Astrology must replace astronomy; alchemy, chemistry; children must be taught

that the sun and moon revolve round the earth, if the Bible is to be standard text-book of the modern teacher of science.

Men who propose to bring about such a change "know not what they do." They do not know the world they live in. For what they have set out to do is to turn the hand of the clock of progress back to a point it reached four thousand years ago—to a point when teachers of anatomy assured their students that woman was made out of Adam's twelfth rib. If Fundamentalists push their proposal to the point of practice, they will certainly smash the "rock of ages" but they will leave unharmed the "record of the rocks."

Prof. G. ELLIOT SMITH, M.D., F.R.S.,
Professor of Anatomy, University College, London.

THE proscription of the teaching of evolution in any university cannot fail to destroy the influence and in fact the very existence of such an institution. For the purposes of a university are to advance and diffuse knowledge and to inculcate the discipline of the search for truth. To deny it the freedom to cultivate these objects is to eliminate its right to exist.

Such action can do no harm to the theory of evolution: nor can it stifle the spirit of truth. But it does reveal the depth of ignorance and stupidity of those who assume that it is possible in the twentieth century to suppress intellectual freedom and to eliminate the spirit of honest inquiry from any community. Moreover, the ignorance is not merely of science but even more of the lessons of history. This campaign for fettering intellectual pursuits has been pursued with a variety of excuses for more than three centuries. In spite of ephemeral triumphs it has invariably ended in disastrous defeats, injuring the misguided fanatics themselves far more than the cause of truth they are trying to stifle. For it is clear the Tennessee comedy is not concerned primarily with evolution: it is essentially the three-century-old attempt to destroy intellectual freedom. The denial of evolution now occupies the place that even so recently as fifty years ago certain theologians assigned to the claim that the earth was flat and fixed in space.

But the reality of evolution is as certain as the fact that the earth revolves around the sun. The former is as essential a part of all modern biological thinking as the latter is of astronomy. Hence the change of the issue does not help those who are stupid enough to imagine that the fact of evolution can be suppressed.

In 1615 Galileo was summoned before the Inquisition, which unanimously declared his proposition that "the sun is the centre and does not revolve about the earth" to be "foolish, absurd, false in theology, and heretical, because expressly contrary to Holy

Scripture." In spite of repeated humiliations, certain theologians (and especially those in the Southern States of America) only finally abandoned these claims that did infinite harm to their own cause less than fifty years ago. The substitution of the biological for the astronomical issue can only result in adding vitality to the ridicule that is certain to overwhelm these misguided people, who know not what they do.

Prof. W. C. McINTOSH, D.Sc., F.R.S.,
Emeritus Professor of Natural History,
University of St. Andrews.

TRAINED from early days in biology on the shores of the rich Bay of St. Andrews under William Macdonald, George E. Day, and Miss Otté, the translator of De Quatrefages' "Rambles of a Naturalist," and later under George James Allman and John Goodsir in Edinburgh, before the appearance of the "Origin of Species," it has been my fate to witness all the vicissitudes of support and opposition (often with personal knowledge of the men) to which this epoch-making work gave rise. Close occupation in zoology and a disinclination to theorise have prevented personal work in a field so fascinating and so fruitful to many, yet such could not check an impartial judgment of the facts. In Great Britain about fifty years ago, it is true that the leanings for and against evolution were each in turn keenly opposed in elections for certain university chairs. It is long, however, since such straitened views have disappeared, and men of every grade of opinion on the subject have been dispassionately chosen on their real merits, and perfect freedom of opinion afforded to university and other teachers. This experience has not resulted in the lowering of the esteem for what is good, nor has it altered the value of the Bible or of religion, nor has it undermined the moral principles and character of the nation—upon which so much depends.

The breadth of view and the great impetus the evolutionary theory has given to the study of the natural sciences cannot be denied. Its value, for example, is of the greatest importance in grasping the relationships of fossil and recent types of every class, from the simple Palæozoic forms to those of the Pleistocene period. Knowledge is a universal goal, and scientific knowledge especially cannot be hampered by restrictions, however well intended. It seeks truth only and labours long to find it. The teaching of evolution in schools and colleges of the United States was perhaps unknown to many in Great Britain, but the veto of some of the American States authorities against such teaching seems to carry us back to the Middle Ages, when free thought and conviction on

certain subjects were fraught with violent opposition and danger. I do not hesitate, therefore, in joining my scientific colleagues in protesting against this infringement of freedom of thought—affecting responsible officials of high character in universities and schools of the United States.

Rev. HILDERIC FRIEND,
Wesleyan Minister.

My biological researches commenced close on half a century ago, when the Churches were almost all strongly opposed to Darwinism. My bias, therefore, was, from the outset, against the theory of evolution. Yet every step taken in the study alike of botany and zoology, of anthropology and religion, tended to show me that the secret of life was to be found, if anywhere, along the lines of evolution; and there was no other theory in the field which could meet all the difficulties involved in the mystery of life. Genesis states a fact, evolution attempts an explanation.

As a student of divinity, long familiar alike with the idea that science and religion were in conflict, and that the doctrine of evolution intensified the supposed antagonism, I have found in that doctrine the most satisfactory solution of my problems as a teacher. I owe much also to the fact that, in my plastic years, I resided in the East, and became familiar with Oriental imagery and modes of thought.

I find the doctrine of evolution in fullest harmony with all that I have been able to discover by practical study of Nature and comparative religion, as well as by personal experience. While I have the highest respect for law and order, I cannot but wonder that the making of laws relating to the education of the race should be in the hands of men so reactionary and ill-informed; men who have failed to learn anything from the past. All history teaches us the unwisdom of opposing new modes of thought. Christ had to insist on a revision of the Mosaic law, as being out of harmony with the thought of the age, and time has in fullest measure justified his action. The Church in vain attempted to suppress the teaching of Galileo. If this thing is of men (as a wise man once remarked) it will come to nought; but if the doctrine be true it cannot be overthrown. The truth will prevail. Nothing can be gained, and much will inevitably be lost, by any attempt to enforce legislation against the teaching of evolution.

It must, however, be conceded that much present prejudice and misunderstanding is due to the want of thought and tact often displayed by propagandists. For the future, in order to obviate these things, the teaching of science as well as that of religion must be entrusted to our wisest, best, and most carefully

trained educators. Whatever of error there may then be in their teaching will eliminate itself, and the doctrine of evolution may safely be left in their hands to establish itself if it be true, to develop and unfold if it be imperfect, or to perish if it be false.

F. A. BATHER, D.Sc., F.R.S.,
Keeper of the Department of Geology, British Museum
(Natural History).

THIS medieval gesture is curiously half-hearted. Complacently to accept the material benefits of research and to reject the intellectual results, to prefer the electric light to the light of reason, the loud-speaker to the still small voice of the spirit: this is worse than a frank return to the Dark Ages. But the attackers of evolution have apparently never considered what is meant by it. Possibly some of its defenders also have not considered. The attack at any rate is confined to organic evolution (atoms and automobiles may evolve as they please), and the spear-point of it is directed against the statement that man is descended from the anthropoid apes. Few would accept so crude a statement nowadays, but any statement that zoologists could substitute for it would, no doubt, be equally objectionable.

Education, however, is the field of battle, and a teacher may perhaps grant something to the other side. Evolution is a theory of creation. There are other theories, and some of them, held by thousands of well-meaning people, may not be taught in the State schools of certain countries. Perhaps it is just as well not to teach any theories. A teacher who is not himself an investigator is liable to be too dogmatic and to bring forward a theory as a ready-made explanation of matters which he is really (like the rest of us) unable to explain. The right of free thought and free speech is one thing; the guidance of the young is another.

As a palæontologist I should be quite prepared to teach facts, leaving their philosophical interpretation for later years. The intelligent among my pupils would probably come to the same broad conclusion as all palæontologists have come to, and they would have had a better intellectual training than if the theory had been forced into them.

Are not the Americans a little too ready to substitute theory for fact in their educational courses? Perhaps this attack is the inevitable reaction, and it may prove not unwholesome. It would do us all good to drop "that blessed word Evolution" for fifty years.

The controversy will be entertaining and a boon to the newspapers; but is it seriously supposed that all the eminent biologists in the world could convert Mr. Bryan and his friends? As easily would President Osborn convert Mr. Bateson to his particular belief.

D. H. SCOTT, D.Sc., F.R.S.,
Lately Honorary Keeper of the Jodrell Laboratory,
Royal Botanic Gardens, Kew.

THE resuscitation, in certain of the United States, of the old "Science *v.* Religion" conflict is a curious and interesting phenomenon, which need not seriously disquiet the scientific world. The Fundamentalists are quite right in holding that a belief in evolution is fatal to their own stereotyped form of religion. If religion is to be wholly unprogressive, then science also must be kept stationary; otherwise a collision is inevitable, and science is bound to get the best of it in the future, as she has constantly done in the past.

The surprising point about the American conflict is that it has come so late. Sixty years ago, when Darwinism was young, we were quite accustomed to this kind of antagonism in England, though it does not appear that we ever went so far as to prohibit the teaching of the new doctrines.

It may be doubted whether, among scientific men, there are any now living who reject the theory of descent. From a biological point of view this is, in fact, the only theory in the field, for the old doctrine of special creation was no more than a confession of ignorance. To account for the origin of species by asserting that species were created by the Deity is as if we were to attribute the origin of the Himalayas to the act of God, instead of trying to find out how and by what forces their elevation was accomplished.

It is probable that those who dislike evolution may have been misled and unduly encouraged by the recent frank statements of some eminent biologists, who have acknowledged how little we know of the methods of evolution. The difficulties are no doubt more fully realised now than they were a quarter of a century ago. But Mendelism and its implications no more cast doubt on the reality of evolution than the theory of relativity invalidates the discoveries of Copernicus.

Of late years I have often had occasion to direct attention to the difficulties in tracing the course of evolution in the plant world. The problem is extremely involved, and many questions must be left open. None the less, the general conclusion that the past history of plants, like that of animals, is nothing but the record of an evolutionary process, remains firmly established.

REV. FRANK BALLARD, D.D.,
Christian Evidence Lecturer for the Wesleyan
Conference.

It is difficult to write with judicial calmness concerning the state of affairs exhibited by the approaching "trial" of Mr. J. T. Scopes for teaching evolution in

the Tennessee High School. The assumptions of Fundamentalism are so preposterous, alike in theory and in practice. I am not altogether surprised, when I call to mind my experiences in America a quarter of a century ago. It was pitifully manifest then, that both in science and theology, many of those who posed as authorities were half a century behind the times. But one did hope that the intervening years would have opened their eyes. The notion of a Judge's charge to a grand jury beginning with the reading of the first chapter of Genesis—"as the account of creation which Tennessee teachers *must* adopt"—of course in the Fundamentalist sense—savours of the sixteenth-century rather than the twentieth.

In view of the whole case, there are two questions which loudly call for unequivocal answer. (1) The first is whether universities are to be free to teach what is true, in the light of advancing knowledge, or are to be for ever throttled by the grip of theological obscurantism. Unless this latter alternative be met with an overwhelming negative, humanity must simply drift back to the miserable darkness of the Middle Ages. (2) The other question is whether the view of creation, with all its consequences, which is dogmatically insisted on by Fundamentalists, is so true that nothing more remains to be learned.

It is not too much to say that, in these days, every child in a respectable school knows that it is not. Whatever room and need there may be for the correction of Darwinism, and the re-statement of evolution in the light of our latest knowledge, this certainty emerges, as plainly as the light of dawn after the dark, that the "creationism" which pivots itself in the opening chapters of Genesis is wrong; and its inferences are as false as they are dangerous, as mischievous as they are dogmatic. Neither God nor man is such as the Fundamentalist shibboleth declares. To say nothing of palæontology, biology, and embryology—save that they cannot now be extinguished by ecclesiastical anathemas—every Fundamentalist bears about in his own body a hundredfold proof that his main contention is untrue. That ought to suffice, not only for all the twenty thousand who are to fill the stadium for the "trial" of July 10, but also for every sane and sincere man or woman on earth.

W. BATESON, D.Sc., F.R.S.,

Director of the John Innes Horticultural Institution,
Merton, Surrey.

I AM glad to add a few words to what I wrote in NATURE of September 1, 1923, p. 313. The Tennessee trial is something more than a curiosity in the history of civilisation. Wherever science and learning are valued, sympathy with the unfortunate victims of this new persecution will be unanimous and deep. They suffer in the cause of truth, if ever men did. To them personally we trust that at least some restitution may be made.

None of us can, however, be indifferent to the issues now being raised on a great scale for the first time in the modern world. The opinions of Tennessee and similar communities respecting the evolution of animals and plants would not seem to be a matter of general concern, but the symptom is really one of grave

trouble, and the tremor now perceptible is an indication of a strain in the social fabric which sooner or later may end in catastrophe. To the nineteenth century, the dissemination and inculcation of scientific truth wholesale was an object almost as desirable as actual discovery. The fundamental and permanent heterogeneity of the population was not appreciated as a fact of any consequence. With education it was expected to disappear. Nothing of the kind has happened. If the true convictions of our own people could be ascertained, I do not suppose they would be found to be very different from those of Tennessee. We are fortunate in having a somewhat larger proportion of the rarer elements as an ingredient in our population—men whose minds are as Plato might have said, "released"; but they are a mere fraction in any community, and it is a miracle that they are able to impose a precarious authority sufficient to protect themselves from molestation.

Upon the still larger considerations which lie behind, we, as scientific men, are not required to pronounce. Whether a State stands to gain or to lose by the encouragement of intellectual freedom in comparison with others which control or suppress truth is a problem on which political philosophers have exhausted the arts both of eloquence and sophistry. No universal solution, independent of time and place, can be expected. But one thing is certain: that to us our liberty is vital; and to suppose that movements of this magnitude in the United States have no significance for ourselves is to cherish a very dangerous illusion.

Sir SIDNEY HARMER, K.B.E., D.Sc., F.R.S.,
Director of the Natural History Departments,
British Museum.

It is difficult for those of us in Great Britain who have recently taken part in the centenary celebrations held in honour of Huxley, the champion of intellectual liberty, to realise the consequences of a successful attempt to control scientific thought, or to believe that a result of that kind is possible in a great country like the United States, which has always prided itself on being the home of freedom. The danger is, however, a very real one on the other side of the Atlantic, and our scientific colleagues there who are fighting the battle can count on the unanimous support of workers on this side.

Considerable harm has been done in America by the failure to realise that a want of agreement as to the causes of organic evolution does not imply any difference of opinion with regard to evolution itself. The evidences for the origin of animals and plants as we now see them, as the result of evolutionary processes, seem to us, as to our distinguished co-workers who stand for intellectual liberty in America, too plain to be doubted. Even if, like Malvolio, we did not approve the opinion of Pythagoras, we should think too nobly of the soul to wish to convert an honest conclusion on the subject into a legal offence.

Among those who are qualified to speak in Great Britain there can be only one opinion: that the attempt to limit the advance of scientific thought is intolerable. History is full of examples which show that progress cannot be stayed, even if it can be

temporarily arrested. It may be anticipated that the principle which is so much feared by a section of opinion in the Southern States will ultimately triumph over its opponents, by the inexorable evolution of a more rational attitude of mind. In the meantime, much harm may be done, and it may earnestly be hoped that the supporters of a policy of intellectual slavery will be defeated.

ERNEST BARKER, D.Litt.,

Principal of King's College, London.

How far can the public opinion of a State, expressed through its legislature, claim to control the curriculum or the teaching of universities or schools? It would seem to me that any State may demand that this or that subject should be taught in any place of instruction which is supported from public funds, but that no State is entitled to prescribe what should actually be taught about any subject. The reason is simple. The aim of all teaching is to awaken and train intelligence. No teacher can awaken or train the intelligence of his pupils unless he is using his own intelligence freely. If a teacher teaches what he is told to teach, he teaches by rote a lesson which his pupils learn by rote. Without freedom, he is also without self-respect; without self-respect, he cannot earn the respect of his pupils; and failing to earn the respect of his pupils, he fails to produce any effect upon their minds. All education depends on the free contact of a teacher, teaching spontaneously, with pupils who are attracted by the suggestion of his teaching and drawn thereby into study on their own account. No man can draw others to himself unless he is speaking from himself.

The very genius of liberty which inspires representative bodies, and is the breath of their own existence, must prevent them from killing the genius of liberty which inspires places of education and is the breath of their existence. A legislature cannot be told what it is to legislate; a university cannot be told what it is to teach. Public opinion is a great thing; but there can be no healthy public opinion without discussion, and no genuine discussion without a genuine and free education. If a legislature tries to kill liberty of teaching, it stultifies itself—based as it is itself on freedom of speech. If public opinion seeks to stifle freedom of thought and expression, it commits suicide; for public opinion can only be formed by freedom of thought and expression. A democratic State cannot kill liberty or stifle freedom of thought without killing itself and stifling the breath of its own life.

Prof. D'ARCY WENTWORTH THOMPSON, C.B., F.R.S.,

Professor of Natural History, University of
St. Andrews.

WHEN the wisacres of the backward States, with their true herd-instinct, take to quarrelling over whether evolution should be taught or no, it is some consolation to think that worse mischief might perhaps be found for such idle hands as theirs to do. If they did no more than forbid the teaching of evolution in their elementary schools, I should even be inclined to agree with them; for I feel myself none the worse that no

schoolmaster ever dreamed of teaching Darwinism to me, nor has it ever been among the lessons which my own children learn. Few schoolmasters are really fit to teach it, and children have other fish to fry.

That these good people should insist on setting the Book of Genesis against the "Origin of Species," and should hate the one as they love (or profess to love) the other, is a sadder thing. The lessons of the last sixty years, the philosophy of evolution itself, should help us all to appreciate them both, and to see in the Mosaic cosmogony as noble a poem as ever was in all the world, and a living monument of profound wisdom and very ancient science. The longer I live the more beautiful it seems to me,—the more beautiful and the more vitally and essentially true. The child cannot understand it all; who is there that can? But if it be withheld from him, he is robbed of part of his heritage.

When democratic licence lets these foolish and fanatical men impose their folly on the universities and play havoc with the public libraries, then our American friends and we ourselves may well be dismayed. Dr. H. F. Osborn and his colleagues are smarting under insult and injury, but the protest they have drawn up is moderate in tone and faultless in expression. I admire the restraint they display under the gross provocation they have received. What they want (but they are too courteous to say so) is "a bridle for the ass, and a rod for the fool's back."

Rev. ERIC S. WATERHOUSE, D.D., M.A.,

Wesleyan College, Richmond, Surrey.

THE action of certain American states, which have set a ban upon the teaching of Darwinism, is evidence of a curious but frequently-noted fact that, in theological matters, the newer countries are more reactionary than the old. The great majority of clergy and ministers in Great Britain accept the theory of the evolution of species. It has appeared within recent years that some of Darwin's positions are not likely to be sustained; especially as regards the importance he attached to the accumulation of small variations, and to natural selection. But the main position of the evolution of species, as against the doctrine of the special creation of "natural kinds," is well-nigh impregably based.

Modern Christianity understands that the cause of truth demands absolute freedom of research and statement. The basis of all scholarship is the belief that truth can be attained. Religion must hold that what is true cannot possibly conflict with it. Unfettered search for truth will involve that mistakes are made and errors are accepted as true. But the same process will in time provide also the remedy. Those who hold that Christianity is true should also hold that no scientific or philosophical truth can be detrimental to it, even though such truth may upset ancient dogmas. Conversely, it follows that anything set forth in the name of science or philosophy which is incompatible with those broad truths to which man's religious experience bears witness is to be suspected. Surely ultimate truth must be such as satisfies all our values, intellectual, moral, æsthetic, and religious.

Prof. J. GRAHAM KERR, F.R.S.,
Regius Professor of Zoology.

THE fact of evolution is one which is now verifiable by the student of even elementary embryology, who can observe for himself the successive stages by which any one of the higher animals evolves out of the simple unicellular zygote. In the case of man himself it can be seen that he is for a time provided with gill-openings in the sides of his neck and that he has other temporary peculiarities which would justify his being classed with fishes were only his embryonic structure known. That the process of evolution was characteristic of the past history of the race, as it still is of the individual, is shown by many paragraphs of geological history—the most beautiful of them all being that provided by the rocks of the American continent chronicling the evolution of the skeletal peculiarities of the modern horse. The only persons who can at the present day have honest doubts regarding the broad facts of evolution are (1) those who are ignorant of such facts as I have indicated and (2) those whose conception of God permits them to regard His records, as inscribed in the rocks and in the embryonic body, as a whimsical series of deceptions. If the legislators of Oklahoma and Tennessee belong to the first of these categories, their opinions may be expected to change with inquiry—and I would indeed recommend such inquiry into the facts of Nature as a charming and delightful relaxation from their legislative labours—but if they belong to the second there is, I fear, little hope of modification of their strange, and as they appear to me, somewhat pagan doctrines.

No doubt it might be argued that the main point at issue is not whether evolution is a fact but rather whether thought is to be subject to the control of authority. We have seen of recent years manifestoes exemplifying such control—emanating it may be from Berlin, or from Moscow, or from Peking, or it may be promulgated by the governing council of some social or industrial organisation. The effects in the way of hatred and war that are liable to result from such policy have been so amply demonstrated in the past, and are so clearly apprehended for the future, that I find it difficult to believe that its open adoption will find any considerable body of support in the United States.

Prof. R. C. PUNNETT, F.R.S.,
Arthur Balfour Professor of Genetics, University of
Cambridge.

To one who has never set foot on the American continent, it is difficult to suggest the real meaning of the curious outburst against freedom of thought which has made its appearance in the Southern States. That it is anything more than a sporadic phenomenon is hard to believe. The firm outer crust of civilisation which has gradually set through the long centuries may at times show local disruption, especially in lands with little tradition of disciplined thinking. Where the will to ignorance exists, the forces of obscurantism may from time to time break out with sudden violence, but that they will ever engulf the

globe seems a possibility as remote as the return of the solar system into the nebular phase. After all, it is in his powers of reasoning that man differs most from other animals, and without them he could neither feed nor clothe himself.

This inherent capacity for rational thinking, without which daily life would be impossible, is surely a sufficient guarantee that obscurantism in the long run will never prevail. If we admit so much, it is all to the good that the greatest possible publicity should be given to the trial of Mr. Scopes. It will lead to some interest in these matters on the part of millions to whom, at present, evolution is nothing but a longish word that sometimes appears in a cross-word puzzle. It will bring them into contact with facts, which are at once the best stimulant to curiosity, and the best antidote to obscurantism. Let us therefore hope that the combined enterprise of the newspapers, railways, and cinemas will lead to the erection of an even larger stadium than that proposed. Though the lawgivers of Tennessee may make the angels weep, they hold out a promise of infinite entertainment to a world that is often rather bored with life.

F. A. DIXEY, D.M., F.R.S.,
Subwarden, Bursar, and Lecturer of Wadham
College, Oxford.

THE growing agitation against the teaching of evolution in several of the states of the American Union is nothing less than astonishing. If there is anything whatever that is well established in the conclusions of natural science, it is the general doctrine of organic evolution. The details of the evolutionary process are still matters of legitimate discussion, but as to the main fact that the present aspect of organic nature is the result of evolution, there is absolutely no question among those who are competent to form an opinion on the subject. But even if the doctrine rested upon a less assured foundation of observation and research than is actually the fact, it is no less deplorable that in a civilised country like the United States an organised attempt should be made to check the process of inquiry into the truths of Nature. Whatever excuse there may have been in former ages for limiting the scope of free investigation, and for visiting with penalties those men who ventured to bring their powers of reasoning and observation to bear upon the conclusions sanctioned by authority, no such excuse or palliation exists at the present day.

The futility of all efforts to impede the progress of scientific discovery has been amply demonstrated, and it might have been supposed that this would have been brought home to the consciousness of all but a few fanatics. That the reality is far otherwise has unfortunately been made fully apparent by the activities of the Fundamentalists in the Southern States of America; and it must be recognised that the forces of obscurantism have increased in certain parts of the North American continent to a pitch which actually constitutes a public danger. The fullest sympathy is due to those men of science in the United States who are striving to rescue their country from the reproach of hostility to the cause of truth and knowledge.

Prof. J. COSSAR EWART, M.D., F.R.S.,
Regius Professor of Natural History in the
University of Edinburgh.

THE coming trial of Mr. J. T. Scopes reminds one of the case of Prof. Robertson Smith, whose articles on Biblical subjects half a century ago greatly distressed and alarmed the authorities of the Free Church of Scotland. Professors in the Free Church Colleges were required before induction to sign the Confession of Faith, which implied, amongst other things, that they would be guided in their teaching by the first chapter of Genesis. After full consideration, Robertson Smith's articles were adversely reported on by a committee of the General Assembly of the Free Church, with the result that he was removed from his chair in the Aberdeen Free Church College. According to Sir Arthur Shipley, the fight made by Robertson Smith for intellectual freedom made him the "most popular if not the most powerful man in Scotland."

There is no evidence that during Darwin's lifetime any professor in the Scottish universities lectured on the doctrine of evolution; but since 1882 the evidence in support of the origin of species by natural selection has been frequently dealt with by teachers in Scotland. It is doubtless true that for some time in Scotland Darwinism was regarded by some as an "unpleasant apparition." This may be partly accounted for by the fact that in 1882 the president of the Royal Society of Edinburgh was a Scottish judge who had no interest in biology, and partly by the presence of several clergymen on the Council. Fortunately, largely by means of courses of lectures in the University of Edinburgh, on the philosophy of natural history, by the late G. J. Romanes, the alarm which for a time prevailed all but subsided; that any opposition that existed has almost entirely died away was made evident by the popularity of Sir Arthur Keith's recent lectures in Edinburgh on the "Story of Man's Evolution as told by his Fossil Remains."

E. N. FALLAIZE,

Hon. Secretary, Royal Anthropological Institute.

THE attempts to discourage the study of evolution which have been made in certain legislatures of the United States, as well as the impending trial in the State of Tennessee, have naturally aroused considerable interest among anthropologists in Great Britain. A ban on evolution would virtually affect the progress of anthropological science not only in so far as it affects the origin and descent of man, but also as rendering meaningless the conception which serves to give unity and direction to the study of human culture as a whole. The importance of these studies in relation to the general advancement of knowledge needs no emphasis, while any system of higher education which omits to take into account the systematic study of man and his culture is deprived of one of its most important elements as an educational discipline. A generation growing up under a scheme of education thus mutilated would find itself cut off from the general stream of intellectual progress and isolated from the culture of the remainder of the educated world.

On the general question of the relation of the State to scientific inquiry, it is impossible not to deplore a movement which seeks to fetter individual freedom of thought and investigation, and at the same time attempts to justify such interference by submission of the questions at issue, not to a scientific tribunal, but to a court composed of laymen without scientific training, and governed by rules of evidence which have no validity in scientific investigation. Should the obscurantist influences which have promoted this action in the State in question prove strong enough to carry the day by force of numbers, the result will appear derisory to the rest of the civilised world; but unfortunately it will deal a disastrous blow to science in the United States, and indirectly to scientific investigation as a whole throughout the world.

Prof. SYDNEY J. HICKSON, D.Sc., F.R.S.

Professor of Zoology, University of Manchester.

A LITTLE while ago a student in my class took the opportunity which an examination afforded to dissent from, and to criticise severely, a view which I had expressed in my lectures.

I took the line of action which I think all my colleagues in this country would have taken of giving him a mark for his answer irrespective of the views he expressed, suppressing an inclination I felt to mark him a little higher for the courage he showed in dissenting from the views held by his examiner.

In a university where the teachers are free to teach, the students must be free also to accept or reject the theories they are taught. Suppression of free teaching must lead to suppression of free learning. The students will leave their high school or university trained in the belief that the theories and conceptions of the universe they have learned are true and that anything else is false. This can only lead to a form of mental stagnation in the generation which it is our duty not only to instruct but also to stimulate to search for truth in the wide fields of science.

In the correspondence which has been published about the Tennessee State law on the teaching of evolution, a great deal has been written about the importance of the liberty of the teacher. With all that we must cordially agree. But let us also plead for the liberty of the taught. Let us insist that in a free country the young men and women should be trained to think, encouraged to discuss, and free to form an opinion. The dogmatic teacher produces dogmatic pupils, and a State that insists upon dogmatic teaching produces a race of citizens deprived of that liberty of thought which is essential for its progressive development.

Prof. J. STANLEY GARDINER, F.R.S.,

Professor of Zoology and Comparative Anatomy,
University of Cambridge.

IN all ages and in all climes men have striven for truth, and in the march of progress men have attained no step after more persistence and suffering than the right to a free utterance of the truth that in them lies. Real religion and science have in common this passion for truth, eternal and indestructible. In its search for truth, science begins with the demonstrable

facts, and from these humbly and gratefully draws conclusions. These are not in the nature of permanent dogma, and, as more evidence is attained, further conclusions are drawn.

Let legislators, who ban the teaching of evolution, think what they are doing, and, above all, whether they will not defeat their own ends. The technique of all teaching prepares the ground for theories of evolution. The biologist teaches facts, but the road for the student has already been paved, and the latter naturally strings these facts together in an evolutionary form. I know no professor of biology who requires to teach the broad theory of evolution, for, with a little knowledge of facts, his students, universally and of their own initiative, deduce it for themselves. What the professor does is to discuss how evolution may have come about, its extent and its limitations, endeavouring thereby to teach his students to think logically, that is, sanely. Applied to life his students find that they have learned the principles, not of militant atheism and communism, but of sane and orderly progress, on the due understanding of which depends the prosperity of States. Let those in authority think well of the advice of Gamaliel: "If this counsel or this work be of men, it will come to nought: but if it be of God, ye cannot overthrow it; lest haply ye be found even to fight against God."

EDWARD CLODD.

THE savants of America need no assurance from their brethren on this side of the Atlantic that they are as one with them in their struggle to maintain the liberty of thought and its expression which are the instruments of progress, the legal suppression of which is the aim of the so-called Fundamentalists. That the theory of evolution is based on a bedrock of facts unshakable has no weight where passion, prejudice and ignorance impel undisciplined emotion. Hence, to this type of mentality, reason appeals in vain. Against this are cited the contents of a miscellaneous collection of ancient writings of uncertain authorship, age and meaning, the interpretation of which has riven Christendom into hundreds of "warring sects." We may envy the Greeks of old, of whom, in his brilliant "History of Freedom of Thought," Prof. Bury says, they "fortunately, had no Bible, and this fact was both an expression and an important condition of their freedom."

The attitude of these obscurantist heresy hunters is clear enough. They hold that belief in evolution imperils the souls of men; hence the fanaticism which would prohibit its teaching. To these malignants no quarter can be given: their fictions and fallacies "debase the moral currency." It cannot, as W. K. Clifford says, "be true of my race and yours that to keep ourselves from becoming scoundrels we must needs believe a lie."

Prof. ARTHUR SMITHELLS, C.M.G., F.R.S.,
Emeritus Professor of Chemistry, University of Leeds.

THE control of education by political or sectarian authority must always involve potential danger to intellectual freedom, but it costs an effort to believe that, at this stage of human history and in the New World, we are in the presence of a serious threat on the part of popularly elected State authorities to use

political law for suppressing knowledge of the laws of Nature.

It is to be hoped that the intellectual world of the United States will rise to the occasion, and that its members will undergo any kind of martyrdom rather than tolerate so great a scandal. They may be assured of the sympathy and support of multitudes in every civilised country in resisting this extraordinary recrudescence of a type of persecution which was thought to have passed away for ever with the Dark Ages.

The universities, above all, will be called upon to fight on the side of freedom, and it seems inconceivable that they can show any timidity or any willingness to traffic in compromise. The first rights of a teacher, the cause of science, the dissemination of truth, are assailed once more by bigotry and fanaticism in the seats of authority. It seems superfluous to insist upon the importance of the issue or on the need of an unqualified victory over the powers of darkness.

In recent times voices have been heard proclaiming the doom of our modern civilisation. Let learning go into captivity, and surely enough these prophets of evil will be justified!

Rev. J. SCOTT LIDGETT, D.D.,

Warden of the Bermondsey Settlement, London.

THE agitation about the teaching of evolution in the United States raises most important political, scientific and theological questions. In regard to them all the controversy appears to me to be disastrous. For a State legislature to attempt to decide questions of scientific evidence is fatal to the interests both of truth and freedom. It extends the authority of the State to realms quite beyond its legitimate province, and carries us back to the Middle Ages. From the scientific point of view, the contention that the doctrine of evolution is a "mere guess" is to show complete ignorance of the immense body of facts that have been ascertained, and of reasoning that is securely based upon these facts. What is most injurious of all, however, is the supposition that the truth of Christian Theism depends upon any particular hypothesis as to the method of divine action in creating, or constituting, and in sustaining the universe. The philosophy of Theism is much profounder than this. To many Theists, the attempt to treat God as so external to the universe that His action can only be explained as that of Omnipotence acting upon it from without by mere acts of will, is to run counter alike to the deeper teaching of Scripture as to the organic relation of God to His World, to the deliverances of religious experience properly interpreted, and to any satisfactory philosophy of Theism. It represents the doctrine of Deism, and not of Christianity.

Rev. A. F. DAY, S.J.,

Church of the Immaculate Conception, Farm Street,
London.

ALTHOUGH my opinion on evolution lays no claim to being that of an expert, I feel favourably disposed towards the theory and do not regard it, in any moderate form, as necessarily conflicting with the revealed account of Creation. Even if this were otherwise, the

policy of the Southern and Eastern States could never commend itself to those who have learnt lessons from the past. Indeed, one might well defend Urban VIII. *in re Galileo*—as Huxley did—and condemn Tennessee, Oklahoma and Co. in the present issue. Of course, the teaching of advanced evolutionism lends itself fairly readily to being made the vehicle for communicating an anti-religious bias. To endeavour to inoculate unformed minds with such a prejudice would evidently be taking an unfair advantage. Indeed, such conduct is opposed to science as well as to morality. It is out of place, therefore, even with mature pupils; both science and religion should confine themselves to their respective provinces.

If any one wishes to combat any doctrine which he regards as erroneous, he should equip himself for the task from the armoury of sound knowledge. It is not for the legislature to enter the lists. Nor should the State run the risk of even appearing to repress honest inquiry.

Prof. G. H. F. NUTTALL, Sc.D., M.D., F.R.S.,
Quick Professor of Biology in the University
of Cambridge.

THE leaders of thought throughout the world have for centuries been unhesitating supporters of the principle that intellectual freedom should prevail in university teaching. Therefore, the opposition to the principle which we are witnessing in the United States to-day, in the form of legislation against the teaching of evolution, is of a character which must fill us with apprehension for the future of "the land of the free and the home of the brave," and of the ability of that land to continue thus to describe itself. Involuntarily we ask ourselves, "What next? Where will this end? . . . if the ignorant majority can thus impede human progress towards truth." The resolution adopted by the Council of the American Association for the Advancement of Science will assuredly be approved by all competent men of science.

Sir OLIVER LODGE, D.Sc., F.R.S.,
Formerly Principal of the University of Birmingham.

THE outcry against the teaching of evolution in some of the United States seems so preposterous in Great Britain that the only use we can make of it is to

bethink ourselves whether we are not doing, or wishing to do, or have not done, something of the same sort in connexion with a less established region of scientific inquiry. Actual prohibition may be difficult of accomplishment, but a refined system of boycotting, such as has begun in the United States in connexion with the doctrine and facts of evolution, can be applied with greater ease, and has already been effective in restraining recruits and silencing the utterances of some who might otherwise have been willing to testify to what they know of truth in other subjects. Had Sir William Crookes been a university professor it would have gone still harder with him than it did. *Lehrfreiheit* is only granted with limitations; it is tolerated so long as it does not outrage preconceived opinion and introduce discord into a pre-established harmony.

Rev. S. M. BERRY, D.D.,
Secretary, Congregational Union of England
and Wales.

ALL those who have enjoyed an education steeped in the spirit of freedom will hope that the threat to that freedom in the schools of the United States may be averted. The idea that teachers should be prohibited from teaching the doctrine of evolution because it is opposed to a certain interpretation of the Biblical account of the Creation, seems to progressive minds on this side of the Atlantic both ludicrous and preposterous. To the minds of all progressive churchmen, any such prohibition would be regarded as a set-back to religious progress and a denial of that liberty of opinion in matters of religion which it has taken centuries to win. That such a threat should come from the United States is history's latest irony.

Rev. H. B. WORKMAN, D.Litt., D.D.,
Senator of London University, Principal of Westminster
Training College.

ANY attempt to interfere with freedom in the teaching of evolution is wholly reactionary, and is bound in the long run to be prejudicial to religion. Dogmatism, whether by scientists or theologians, should give place to a greater consciousness of the vast regions of the unknown.

Truth and Doctrine in Science and Religion.

THE vagaries of those near to us in kin are proverbially harder to understand than those of strangers, and it is equally true that it is less easy to appreciate the shibboleths of the generations immediately preceding our own than those of a remoter date. It is undoubtedly a fact that the common element in British culture and that of the United States has often served to obscure certain fundamental differences of which the occasional manifestation sometimes amazes and more often bewilders us. The tendency shown by certain State legislatures in America in their attitude towards the doctrine of evolution, which has culminated in the prosecution of a teacher in the State of Tennessee for the use of a text-book in which a reference to that doctrine was included, is indicative of a public opinion of a force and character which it is difficult for us in Great Britain and in these days to appreciate.

Scientific workers on this side of the water are

accustomed to meet their American colleagues on an equal footing. They expect to find among them a readiness equal to their own to accept the facts which scientific investigation may bring to light and an equal openness of mind in the discussion of the bearing of such facts upon accepted theory. It has, therefore, come with something of a shock to them to find that a movement upon which they may have looked with some feeling of amusement, and as such may not have regarded more seriously than as a passing phase, is likely to prove an obstinate barrier to intellectual progress and freedom of discussion. Those who have followed the trend of thought among the intellectual section of the general public in the United States for any length of time may not be equally surprised. They have been aware that sooner or later some such question as this was bound to arise. It is not so long ago that a well-known American novelist put before his

public, as a living question of to-day, in the church of an American city, the problems which exercised the readers of "Robert Elsmere" when first that book was published in Great Britain nearly forty years ago.

The problem with which the more advanced section of intellectual America is now confronted is as old as the hills, or at any rate as old as man himself. Every age and every country produces its Socrates and its Galileo. Everywhere the prophets are stoned when speculation or scientific discovery comes into conflict with the emotions of the majority.

In Great Britain, it is perhaps safe to say that the cause of intellectual freedom has been won. It is not likely that we shall witness again a struggle over a purely scientific doctrine, such as that which raged around the controversies of the middle and latter half of last century. It is difficult for a generation brought up in the freer atmosphere which is a result of those fierce encounters, to enter fully into the intensity of feeling which was aroused by the theological disputes of the earlier Victorian era. The famous Gorham case and the heated discussion of questions of church government which it aroused, and the Tractarian movement, were only a prelude to the storm raised by the publication of F. D. Maurice's "Theological Essays" in 1854, repudiating the doctrine of eternal punishment, which forced his resignation of his professorial chair at King's College, London; while the heated arguments over the archaeological discoveries of Boucher de Perthes in the Somme Valley, which relegated man to a vast antiquity, merely paved the way for the tempest which followed the application of the Darwinian hypothesis to the problem of man's origin.

The recent celebrations of the centenary of Thomas Henry Huxley have served to recall the many controversial questions in the discussion of which he was a protagonist; of these, perhaps his encounters with Wilberforce at Oxford, and with Gladstone, have remained most firmly fixed in public memory. To his fearless championship of the doctrine of evolution in the stormy years of the 'sixties of last century, following on the publication of "The Origin of Species," is due as much as to any the victory of freedom for scientific inquiry into, and speculation on, the great problems of the origin and development of the forms of life. His conception of the sanctity of truth, and his fearless acceptance of facts whatever might be their bearing upon dogma in any field of inquiry, remain the creed of the scientific investigator of to-day. But that it is generally recognised as right to hold that creed is due to those who bore the heat and burden of that day—Darwin, Huxley, Tyndall and others of their time. Much must be attributed to the force of personality of those who participated in these controversies, and perhaps as much to the writings of one who took no active part in them himself, namely, Herbert Spencer. Spencer's writings, and particularly his sociological writings, by their application of the biological conception and the evolutionary point of view to the study of man as a social being, did much to secure acceptance for the doctrine of evolution among the intellectual public.

Further, in anthropology the work of Tylor in the comparative study of the beliefs of man demonstrated that behind the great religions of the world there lay a long process of growth which could be traced back stage

by stage to the primitive animism of the savage, a work which has been extended and confirmed by the labours of Sir James Frazer. At the same time, the studies of the archaeologists, in conjunction with the geologists, were extending to more and more remote periods of time, and to an increasingly primitive stage, the evidence for man's existence, in the shape of the primitive stone implements which marked his early efforts to control and shape his environment to his needs. Concurrently, the critical study of the Bible—the Higher Criticism—was demonstrating the composite character of its parts, while its sources—notably the story of the Creation deciphered by Smith from the cuneiform inscriptions—were being derived from other than Jewish sources.

It would scarcely be worth while to recapitulate these familiar facts if it were not to recall that, immediately following upon the formulation of Darwin's theories and their discussion, there was a convergence of evidence bearing upon the origin and history of man and on his beliefs, some of it derived from an extended application of the evolutionary method of study, which by superseding the traditional static view, tended to facilitate if not the acceptance at any rate the preservation of an open mind towards the central problem.

To the scientific mind, perhaps it is a temptation to over-estimate the extent to which the cogency of an argument has appealed to the general public. The freedom in discussion of matters of the intellect which has been won in Great Britain must perhaps in part be attributed to the national temperament. The key may perhaps be found in the writings of Herbert Spencer, the apostle of the individualism which is the most marked characteristic of the Englishman. The appeal to authority which is the negation of the intellectual freedom postulated by scientific inquiry is by tradition and training alien to the British temperament. The nineteenth century in Great Britain was a time of intellectual ferment in the political as well as the scientific world, but in both cases it was the culmination of a movement which had been in being for centuries. The demand for "Civil and Religious Liberty," which was the war-cry of one of the great political parties of the day, was merely the traditional spirit which gave rise to the Reformation, to nonconformity and to the reforms of the Philosophical Radicals at the beginning of the nineteenth century.

It may be that it was by good fortune that the battle of the Darwinian hypothesis and its extension to the evolutionary theory was fought on favourable ground. That for us of to-day is a matter of history. But it lays upon those who hold the torch to hand it on undimmed and to watch jealously that, in changing conditions, no change can affect the unity of free and unfettered discussion in all matters that appertain to the pursuit of knowledge. In these days, when science is universal and co-operation in scientific research transcends national boundaries, it is impossible that what affects a part should not affect the whole. The whole scientific world will therefore watch with no little interest and anxiety the result of a trial which may by its results affect the intellectual progress of one of the great nations of the world. Not only may it stunt the intellectual growth of generations: it may also debar her from all participation in the advancement of one of the most important of the branches of knowledge.



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Biology and the Fur Trade.

DURING the last quarter of a century there has been an enormous increase in the demand for furs. In the United States alone, according to Mr. David C. Mills, the general director of the National Association of the Fur Industry, "the annual catch of fur bearers in the United States was roughly estimated at about twenty-five millions of dollars twenty-five years ago. We estimate it roughly at sixty millions to-day, with quantities fairly well maintained, on the whole, because of the impetus given to trapping by the higher returns to the trapper." But this impetus means more intensive slaughter. How great the slaughter is may be gathered from the lists of skins exposed for sale at the fur auctions during the winter of 1925. The total number of skins (excluding Chinese and Australian) greatly exceeded four and a half millions, and a few of the larger items included: skunk 652,293, American opossum 456,195, musquash 787,195, squirrel 837,097, mole 357,599.

Such destruction of fur-bearers could have but one result; it has involved the usurpation of the annual increase of the animals, and beyond that a trenching upon the capital stock itself to a serious degree. That the destruction has already gone too far in many areas is admitted on all hands. The officials in charge of the Fur Resources Division of the U.S. Bureau of the Biological Survey, from a detached point of view, state (September 1924) that "the fur trader of the past was interested chiefly in the quantity of pelts he could collect . . . and when the dressing of furs became well established as an industry in the United States, the fur trade began to appreciate the fact that some of the more valuable fur animals had almost disappeared from our forests and streams, and that the production of a large part of the most important fine furs was confined to the Canadian Provinces. While the musk rat, the skunk, and, in places, a few other species are left in considerable numbers, the remnants of this once rich heritage in this country are fast dwindling under present-day conditions." The director of the fur industry association, viewing the matter from a business point of view, is equally emphatic (April 1925): "certain species in some districts have been thoroughly trapped out or at least reduced to a point at which they are commercially unimportant. Broadly speaking, the future of the commercial supply of some of the fur-bearing species in all districts is problematical."

Efforts have been made to check the excessive destruction by means of legislation; but legislation labours under special difficulties in these North American territories. Each State frames its own State laws, with the result that there is often a lack of

co-ordination in adjacent regions, expressed in differences in the species of animals protected, in varying methods of protection, and, even when method and species agree, in serious variations in the period covered by the close season, when the protected creature is supposed to be safe from interference.

It is here that biology has a lesson to teach. Knowledge of the life-histories of fur animals and of the biological zones where conditions of livelihood are more or less uniform, should be able to bring order out of the chaos of legislation. It is to biology that both the fur-traders and the officials interested in animal resources look for rescue from the slough into which the fur industry is sinking of its own weight. It is impossible, and only a narrow outlook could regard it as desirable, to put a stop to those interferences with natural breeding grounds—the felling of woods, the draining of marshes, the tilling of the prairie—which are the accompaniments of agricultural progress and of the march of civilisation. The most that biology can do is to suggest how the stock of fur animals can best be conserved, and at the same time yield a full harvest, in these areas where food, shelter, and suitable haunts still exist.

In the first place it is found that trapping of animals is often carried on after the breeding season has set in. This obviously is biologically unsound; for the death of a breeding animal means the loss not only of an individual, but of a prospective adult progeny. Furthermore, it is uneconomic, since the breeding season marks a period when the pelt deteriorates in quality, to the loss of the trapper and the trader. Everywhere the onset of breeding time should mark the commencement of the "close season," and the open season should not commence until the breeding season has ended.

Here another biological consideration comes into force, further to curtail the open season. At the close of the breeding period the pelts are in poor condition, and the fact that many poor pelts reach the market is a clear indication that in places the trapping season is too long. The casting of the old fur and its replacement by a fresh coat is a routine process influenced by specific idiosyncrasy and by climate, but for most animals the time for prime pelt is limited to a comparatively short period in the autumn. Let this, then, be the trapping season, and the markets would gain by a raising of the standard of quality, and the trapper would be better repaid for his labours during a shorter but more intense trapping season.

Lastly, variations in State-to-State laws should be regulated, first by the amount of the stock, upon the annual increase of which the trapper may safely trench without endangering the capital, and, secondly, by the climatic factors which regulate the routine of the

life-history. Broadly speaking, a maximum open season would exist uniformly among adjacent States ranged along a climatic, or more strictly a climatobiological, zone, the uniformity being broken here and there by shorter close seasons where the natural stock was at a low ebb.

Such are the biological considerations which the officials of the United States Department of Agriculture are endeavouring to work into the legislation of the States. It is matter for thought that while other countries are approaching this high pitch of perfection in the protection of their native animals, Britain has not yet taken even a first legislative step to protect the waning remnant of its land mammals.

JAMES RITCHIE.

The Chemistry of the Sugars.

- (1) *The simple Carbohydrates and the Glucosides*. By Dr. E. Frankland Armstrong. (Monographs on Biochemistry.) Fourth edition. Pp. xi + 293. (London: Longmans, Green and Co., 1924.) 16s. net.
- (2) *Zuckerchemie*. Von Prof. Dr. Hans Pringsheim. Unter Mitwirkung von Dr. Jesaja Leibowitz. Pp. xii + 322. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1925.) 18 gold marks.

THERE is at the present time no up-to-date treatise on carbohydrate chemistry. The last edition of Tollens's "Kurzes Handbuch" was published in 1914, the third edition of von Lippmann's "Chemie der Zuckerarten," in two volumes, appeared in 1904, and Maquenne's "Les Sucres" in 1900. Neither of the books before us can claim to be a treatise on the subject, yet they both form useful additions to the literature.

(1) Armstrong's monograph has gone through four editions in fourteen years, a fact which is in itself a testimonial. Besides having been thoroughly revised and the subject matter to a great extent rearranged, the present edition has been enlarged by the addition to the text of some fifty pages, including two new chapters. The author acknowledges his indebtedness to Principal (now Sir James) Irvine and to Dr. T. P. Hilditch for giving him many valuable suggestions, as well as to Mr. Rex Furness for assistance in the compilation of the enlarged bibliography.

The opening chapter on glucose outlines the general character of this typical sugar and its derivatives, whilst other chapters are devoted to the chemical properties of the hexoses and pentoses as a class and to the carbohydrate alcohols. Stereoisomerism is most ably dealt with, and here the author refers to his own work and to that of Lowry and of Hudson. The disaccharides, tri-saccharides, and the one known tetra-

saccharide, stachyose, are also discussed. The chapter entitled "Configuration and Biological Behaviour" is concerned with fermentation, oxidation, selective hydrolysis by enzymes, and the behaviour of sugars in the blood.

The two new chapters deal with hydrolysis and synthesis and with the polysaccharides respectively. In the former the simple law of mass action, illustrated by the rate of hydrolysis of sucrose, is described. The synthesis of sugars *in vitro* and *in vivo* is discussed. Bourquelot's work on synthesis by enzymes is referred to as proving that when this takes place a balanced reaction is concerned. It is pointed out, however, that the work of the author in 1901, and of Hudson in 1914, proves that the system invertase, fructose, glucose produces no sucrose. It will be remembered that Brown and Morris, working with the leaves of *Tropæolum*, found that the first sugar which could be identified as a result of the assimilatory processes is sucrose. Parkin made a similar observation in the case of the leaves of the snowdrop, and Davis Daish and Sawyer in that of mangold leaves. The first actual sugar to be synthesised is probably a reducing sugar, but the storage carbohydrates are of the nature of sucrose, starch, and the like. Whether sucrose will ever be synthesised *in vitro* must remain an open question; its formation in the plant would seem, however, to be associated with vital processes.

The chapter on the polysaccharides is useful, but it has not been possible to give more than a bare outline of the subject. Pectins and gums are not mentioned.

The chapters on the natural and synthetic glucosides, and on the function of carbohydrates and glucosides in plants, will be read with great interest, containing as they do so many valuable suggestions. Under respiration in plants, a concise account is given of Palladin's theory of respiratory chromogens, whilst Wheldale's work on antho-cyanins is alluded to. In connexion with the tannins, the observations of Kraus and of Busgen that they are structural materials, as instanced by their disappearance from young cork cells, are mentioned, but there is no reference to the work of Drabble and Nierenstein that condensation products giving reactions similar to those of cork are formed by treating a mixture of formaldehyde and phenol or tannin with an acid. This is important as giving a clue to the formation of cork from tannins.

Whilst as a whole the monograph deserves the highest praise, we venture to think that the subject matter might have been better arranged. There is over-lapping, and even repetition, between some of the chapters. This, however, can only be remedied by rewriting and recasting the book; it is unavoidable

when an edition has only been revised and extended. The diction is clear and there are no serious typographical errors. We notice one contradiction in terms on p. 47. "In anhydrous alcohol (which, however, contains traces of water) . . ." This is a mere slip, and it is quite clear what the author means. One important feature of the monograph is that it is written in an unbiassed manner. The author states his own views as well as those of other chemists who differ from him on any point. We cordially recommend the monograph to all students of the subject with which it deals.

(2) Prof. Pringsheim's book is intended by him as a text-book for beginners in sugar chemistry. It differs entirely in its lay-out from Dr. Armstrong's monograph, being more in the nature of sketchy outlines on the subject, in which bare facts are stated devoid of full explanation or of suggestion. It is written almost exclusively from the point of view of the organic chemist, the biochemistry of the subject taking only a subsidiary position. Structural formulæ are reproduced freely, but little detail is given of the experimental data on which they are based. It is only just, however, to add that original references are cited in all cases. The author has condensed his subject matter with great skill, but we venture to think that the text has been reduced to too small a compass, for, in addition to the meagre nature of the arguments justifying the theoretical deductions set forth, there are numerous omissions. Obviously, therefore, such a book can scarcely be recommended, without qualification, as a text-book for beginners, who at the present time are too often trained merely to memorise formulæ rather than to study chemistry logically as a branch of experimental science.

The text is divided into twelve sections under the headings: general properties and constitution; oxidation; reduction; condensations; configuration; anhydrous and reducing sugars; amino sugars; synthesis and degradation of the monosaccharides; biochemical reactions of the sugars; the glucosides and their synthesis; disaccharides; occurrence, preparation, and special properties of the most important sugars. A useful feature of the work is the inclusion at the end of each section of tables giving the melting point, rotatory power, and principal derivatives of the compounds dealt with, as well as references to the literature. References to the literature are also given throughout the text as footnotes.

Such criticism as we have ventured to make demands some justification, and to supply this we propose citing some points from the text. Just over two pages are devoted to the pentoses, of which arabinose, xylose, and ribose are briefly described: lyxose is once mentioned.

Of the hexaketoses, fructose and sorbose only are described. It is stated that, according to Hudson's rule, the difference of the specific rotatory powers of the α - and β -aldoses is approximately a constant; this should refer to the difference of the molecular rotations. It is incorrect that starch can be converted quantitatively into maltose by malt diastase, even in the presence of the so-called amylase complement, as the recent work of Ling and Nanji has shown. Nothing is said of Baker's method of preparing maltose by the action of translocation diastase on starch. There is no reference to the cyclic sugars. The obsolete method of Soxhlet of titrating sugars with Fehling's solution in a porcelain dish is described. Following this, however, is a description of Bertrand's permanganate method. Willstätter and Schudel's iodometric method of estimating reducing sugars is described, but there is no mention of the more recent, improved method of Baker and Hulton. Croft Hill's observation that under the influence of yeast maltase (not maltose, *sic*) glucose yields revertose is referred to, but β -glucosido-maltose and isomaltose, which Ling and Nanji have shown to be constant products of the hydrolysis of amylopectin, are not mentioned.

There can be no doubt that, so far as it goes, Prof. Pringsheim's book will be found useful to the student under the guidance of a competent teacher.

ARTHUR R. LING.

Physiological Optics.

Helmholtz's Treatise on Physiological Optics. Translated from the third German edition. Edited by Prof. James P. C. Southall. Vol. 2: *The Sensations of Vision*. Pp. ix+480. (Ithaca, N.Y.: Prof. F. K. Richtmyer, Secretary, Optical Society of America; London: The Hatton Press, Ltd., 1924.) 30s.

"IN developing the consequences of any valid general principle in individual cases, one constantly comes on new and quite unexpected surprises. And as the consequences are not arbitrary, nor contingent on the caprice of the author, I have often the impression that it is not my own work that I am writing out, but some one else's."

HERMANN V. HELMHOLTZ.

The text of this volume occupies 468 pages, of which nearly one-quarter takes account of new matter extending beyond the original first-edition treatment; and, of that quarter, fully one-ninth part is specially contributed to the American edition. The contributions of the late Prof. Nagel are a note on the stimulation of the organ of vision by Röntgen and Becquerel rays; another on visual acuity; a section on changes of the retina due to light; a note on complementary colours; one on flicker scotoma; and a large appendix on

adaptation, twilight vision, and the duplicity theory. The contributions of v. Kries are a note on contrast, and a long appendix dealing with normal and anomalous colour systems, and with theories of vision. Dr. Christine Ladd-Franklin contributes a new appendix on the nature of the colour sensations.

In his preface to the German edition, Nagel gives his views on the relations of the new work to the older work, as utilised by Helmholtz, in the following words.

"In that region of the 'Sensations of Vision' the main question to be decided first of all was whether Helmholtz's conception of the structure and action of the mechanism of colour perception could still be considered as an adequate explanation of all the new observations that have been made in the last four decades; and if not, whether these ideas should be discarded altogether, or, finally, whether it would be really profitable to introduce here additional supplementary hypotheses. The editor's position on this question is that there is no reason whatever to abandon the fundamental ideas of the colour theory which Helmholtz espoused; although the assumption of the organisation of the mechanism of colour perception in three components is no longer sufficient to give an entirely satisfactory account of all the known facts of colour vision."

Helmholtz so clearly recognised the differences of the rod and cone structures and functionings that, in the first edition of his work, he showed with elaboration (pp. 30, 31, ii., Amer. edn.) that the rods could not act in the same way as the cones, and he considered them to be visually ineffective. The cones he regarded as "the elements that are *peculiarly* sensitive" (italics are ours). Subsequent gain of knowledge gave rise, in the second edition, to the statement that

"From the perfectly analogous anatomical structure of the rods it is extremely probable that they also must have the same sort of capacity; which was the opinion of H. Müller and Koelliker. Nevertheless they must play an entirely different rôle in the localisation of sensations, because, in spite of their being finer and more numerous in the peripheral parts of the retina where they predominate, the power of discrimination between very similar impressions is more imperfect in this region than it is in the fovea."

Since it was known to Helmholtz (second edition) that rod vision is colourless, these statements, if they be not regarded as an actual initiation of those developments of view which have become known as the Duplicity Theory, most certainly pave the way for it. The reticence of his assertions is an example of the characteristic caution and single-eyed aim at the expression of truth which led him to avoid all statements not based on recognised fact. On the whole, from probabilities regarding development of the organ of sight, and also in view of the more recent

investigations, it seems to be most likely that rods and cones are examples of specialisation along a common line, arrest of development towards colour discrimination occurring early in the case of the rods. So that Helmholtz's general scheme of colour vision, including colourless vision as a special case of course, applies throughout the whole range of normal and abnormal vision.

The distinguished developer of the Duplicity Theory, v. Kries, says that "Even at the present time the theory of Helmholtz is thoroughly justified as to its fundamental conceptions," and he corrects "some misunderstandings under which the theory has laboured in many ways." "Fundamentally, the Helmholtz theory was simply the expression of a direct fact of observation, namely, that *the resultant of all the various light stimuli so far as sensations are concerned can be completely represented as a function of three variables*. It is idle to try to explain this fact except on the assumption that the *result of the stimulation* also can be represented completely as a function of three variables." The point may be put even more strongly, for it is the component and resultant *sensations* that are estimated. The equation

$$cC = rR + gG + bB$$

asserts as a fact that the general sensation of type C can be produced by compounding three sensations of independent fixed types R , G , B . It is the psychological trichromasy of all sensations that is asserted. In regard to dichromatic vision, v. Kries says that "the researches have completely verified Helmholtz's conjecture of two main types each due to abstraction of one component fundamental sensation," but he finds difficulty with regard to anomalous trichromasy. The reason is that he overlooks Helmholtz's own use of intertransference, partial or complete, of actions which normally affect one fundamental sensation alone. This is given with other matters in seventy-two precious pages of the second edition, the absence of which from the third is an unfortunate consequence of the adoption of the text of the first edition. Some extracts from the second edition are given. It is regrettable that these pages were not included as an appendix, for they contain the development, by Helmholtz himself, of the trichromatic theory to its highest consummation, in making which he must have had "the impression that it is not my own work that I am writing out, but some one else's."

Dr. Christine Ladd-Franklin gives an account of her views on colour vision, in which she postulates five physiological activities corresponding to red, yellow, green, blue and white. All phenomena of vision can be expressed in terms of five or more activities, but the law of trichromasy, being a psychological law,

asserts that only three are independent. The two conditions, $R+G=Y$ and $R+G+B=W$, which she gives, specify the two interconnexions requisite to limit the independence to the observed amount. The outstanding interest of her suggestions lies in the exhibition of a mechanism, which may prove to be the actual one, which satisfies the conditions for restriction of independence, and accounts readily (as also does the developmental view of Helmholtz's trichromatic scheme) for a fused yellow sensation.

The strictures made in the appendices on Hering's scheme are really unmerited. Any condition explainable on the trichromatic scheme can be explained by his with appropriate specifications.

This volume, because of the wealth and importance of the new matter, should be regarded as indispensable by every student of, or worker in, the subject of visual sensation.

W. PEDDIE.

More Torchbearers of Science.

The Torch-Bearers. By Alfred Noyes. Vol. 2: *The Book of Earth*. Pp. vii+375. (Edinburgh and London: Wm. Blackwood and Sons, 1925.) 7s. 6d. net.

MR. NOYES has followed up his first volume of "Torch-bearers," which was reviewed in these columns on May 20, 1922, by a second and rather larger book, volume ii., with the sub-title of "The Book of Earth." It will be remembered that the first volume was inspired by a night spent in the Sierra Madre Mountains when the first trial was made of the new 100-inch telescope, and it treated of the growth of astronomy from Copernicus to Herschel. It was a notable attempt to carry out the destiny predicted for poetry both by Wordsworth and Matthew Arnold in Great Britain, to express the truths of science in the sort of language which had always served mankind as the vehicle of the highest and eternal ideas. We hailed it as such and are glad to think that the three years since its publication have deepened the public appreciation of Mr. Noyes' effort. The second volume will not be found to belie these expectations. It deals with a much more difficult subject from the point of view of poetic presentation, namely, biology, or rather geology as a preface to zoology and evolution as crowning geology. It leaves one in some doubt as to the scope of the third volume which we are promised in the preface to the first. Is the biology to be completed? Heaven, earth and man would seem to be the natural division. Yet in this second volume we are brought down to Huxley at the famous Oxford meeting of the British Association: so what remains for the third, unless it is to be devoted to relativity and the general

philosophical change in scientific ideas which has taken place in the twentieth century?

It is rather to be hoped that this is not the case, as Mr. Noyes' original instinct was correct: to seek for, and, if necessary, create, dramatic moments to express the onward march of scientific thought. He is least successful in the more abstract parts of his argument, but effective and often moving in his narrative and dialogue.

This second volume begins by thoughts suggested by gazing downward into the Grand Canyon, as the first began by looking upward from the Sierra Madre. The contrast is apt and the field is well chosen from the New World, where land and waters and all the expanses of space are so much vaster than with us. The cantos then proceed chronologically from Pythagoras and Aristotle through the East (Farabi and Avicenna) to Italy with Leonardo da Vinci, France with Jean Guettard, Sweden with Linnæus; and evolution in three cantos, Lamarck and the revolution, Goethe and Darwin.

There are good things throughout, but we will select three as typical of Mr. Noyes' thought in different aspects. The first comes from the second canto, in which the poet imagines a scroll written by Pythagoras and handed by Nicomachus to the young Aristotle as they were walking by the seashore near Stagira. The boy lies down at full length on the rocks and spreads out the papyrus which bids him

"Guard the immortal fire,
Honour the glorious line of the great dead.
To the new height let all thy soul aspire;
But let those memories be thy wine and bread."

A noble song, sustained through seven verses, and giving the keynote of Mr. Noyes' thought in these volumes, the triumph of new truth found by following the footprints of great thinkers in the past.

Our second extract is from the fourth canto—The Torch in Italy. The subject is a conversation between Giulio, the pure artist, a believer in the absolute and self-sufficient inspiration of the moment, and Leonardo, who does not disclose his identity until the last word. The artist proclaims the independence of the artistic inspiration. "All genius is capricious. You'll admit that men who lived like beasts have painted well."

"Yet," replies the stranger,
"For the greatest Art I have always found
A certain probity, a certain splendour
Of inner and outer constancy to law."

This is the note which Mr. Noyes has recently developed, so far as poetry is concerned, in his essays in criticism: it is also of the highest moment for his theme in this book, the essential connexion between the right direction of the mind in both science and art. Each aspect

is creative of new truth, and neither can attain its fullest realisation without elements belonging more intimately to the other.

The part of the book which will attract the most attention is Canto IX., called "Darwin." This contains the most vivid and moving account ever written of the debate at the Oxford meeting of the British Association in 1860. It is evidently based on the reports of eyewitnesses and is an admirable piece of poetic narrative. The tense excitement of a crowded audience, largely clerics, the determination of Wilberforce to crush Darwin once for all, the postponement of the debate, the ticking of the clock until the moment arrives when Huxley muttered low—"The Lord hath delivered him into my hands." The portraits of all the leading speakers, Henslow, Draper, Owen, as well as the two protagonists, are as good as possible. Then the book winds up with the reaction in Huxley's own mind that night after the triumph of the day. Had not his victory "a relish of the dust"? Had he not used more skilfully the unworthy weapons of his foe? Was there not yet a far larger truth than Darwin had proclaimed and he had so successfully defended? And so on to the Epilogue on "The Eternal Mind which enfolds all changes and can never change."

A remarkable and inspiring book.

F. S. MARVIN.

A Quantitative Study of Regeneration in Plants.

Regeneration: from a Physico-Chemical Viewpoint.

By Jacques Loeb. (McGraw-Hill Agricultural and Biological Publications.) Pp. x+143. (New York and London: McGraw-Hill Book Co., Inc., 1924.) 10s. net.

IN view of the sudden loss of Jacques Loeb from the ranks of scientific workers, it is particularly valuable to have in the form of this monograph his own presentation of his views upon regeneration, based upon the long series of experiments he carried out upon Bryophyllum in recent years, recorded so far only in a number of papers in the *Journal of General Physiology*.

In the preface, Loeb states that it is "not more facts which are needed in this field but a method and a principle which allow us to pass from the stage of blind empiricism to the stage of an oriented research." This method Loeb thinks he has found in the study of the quantities of the regenerated tissue by dry weight determinations; the principle he suggests is the simple mass relation thus indicated as determining the amount of regenerated tissue, namely, that it is proportional to the mass of original tissue allowed to regenerate. His point of view brings him sharply into conflict with many views in great favour at the present day, and is

perhaps none the less valuable for that. He rejects entirely the suggestion that wound hormones stimulate new growth, a view much in favour on the Continent under the influence of Haberlandt, and concludes as the result of quantitative studies that the mutilation favours regeneration, because it isolates within a limited mass of tissue, as a severed leaf, a local store of food material which is thus available for regeneration. On the undamaged plant this store would be withdrawn and used for normal growth elsewhere.

The same quantitative attack leads Loeb to another interpretation than that now frequently prevalent, as to the inhibiting action of one growing tissue upon another. Starting from a simple quantitative analysis of the fact that a leaf alone regenerates more freely than a leaf still attached to a piece of stem, he reaches the conclusion that the food supply used for regeneration in the isolated leaf is shared between leaf and stem in the second case, and largely exhausted in growth processes within the stem, including callus formation. He is thus led to reject a view first adopted by him, as is clear from his original papers in the *Journal of General Physiology*, which still seems to emerge in his phraseology when he speaks (in Chapter xii.) of the inhibiting action of the "descending sap from the leaf" upon shoot formation on lower regions of the stem. This inhibiting action he now traces to the fact that the food supply from the leaf is wholly used up in growth processes within the young stem, just as the inhibiting action of an actively regenerating shoot or root upon other shoots or roots later in starting, is put down to the utilisation by the earliest growth centres of all the reserves available for growth. He thus discards the view that the "descending sap" inhibits in virtue of its content in growth-inhibiting hormones (now sometimes termed "chalones").

Loeb's point of view was very physiological, and apparently he never felt the need to work out his conceptions upon a basis of anatomical detail. He was satisfied to interpret his interesting experiments upon the influence of gravity upon regeneration, as showing the movement through the tissues of the plant of soluble substances necessary for growth, so that they collected in the lowest regions and favoured growth there. On experimental grounds he concluded this movement was distinct from the movement of sap in the vessels of the plant, but he never considers further the path by which this nutrient sap moves under the influence of gravity. Again, his experiments upon polarity lead him to the conclusion that the *anlage* of the regenerated shoots and roots must lie in different regions of the plant, but he makes no reference, for example, to the detailed anatomical investigation of cases of regeneration from leaves, in which it has been

shown that shoots may originate from epidermal cells whilst roots always arise from cells in the neighbourhood of the vascular cambium.

Loeb's experiments may be in many respects open to criticism; one criticism already made has been that Bryophyllum plants do not always behave like Loeb's plants. But there can be little doubt that Loeb has placed on record a series of valid quantitative data which do supply some guidance as to the phenomena involved in regeneration, and though their complete interpretation will require much further work, involving correlated studies in anatomy, cytology, etc., Loeb has once again blazed a pioneer trail in his steadfast insistence upon quantitative work in a field which is almost obscured with descriptive qualitative details.

Relativity and the Metaphysician.

The Tyranny of Time: Einstein or Bergson? By Charles Nordmann. Translated from the French by E. E. Fournier d'Albe. Pp. 217. (London: T. Fisher Unwin, Ltd., 1925.) 10s. 6d. net.

ALL our life we have looked with awe on metaphysics; its problems are so abstruse and the meaning of the metaphysician's solutions so difficult to understand. Occasionally a doubt arises in our mind whether metaphysics is empty words with no reality behind. But we always suppress the doubt. For how could a subject be mere empty words which has held such an exalted and honourable position through all the ages from the brilliant era of the Greeks down to our own times.

Then comes Einstein's doctrine of relativity. The aim of the metaphysician is to take the laws of Nature, including those provided by mathematicians and physicists, and fuse them into an intelligible whole. It is, therefore, incumbent on him to understand Einstein's doctrine. Even if he rejects it, he must first understand in order to be in a position to reject it. A study of the treatment of relativity by different metaphysicians brings us a little nearer to the answer to our question whether they deal with words or with realities.

The first group treat the subject with all the understanding of the mathematician. It is, in consequence, open to us to believe that those portions of their work that are beyond our understanding are equally sound, and our respect for them continues.

Another group find all the knowledge of the doctrine that they need in the word "relativity." The name reminds them of Bishop Berkeley, who believed in the relativity of the external world in the sense that that world existed only if there was a conscious mind present to perceive its existence. This group is content to identify Einstein's doctrine with Berkeley's.

A third group have studied Einstein's doctrine and

have failed to understand it, and, at the same time, are unconscious of their failure. The author of the book named above belongs to this group. The object of the book is to decide between Einstein who teaches that the simultaneity of two events is relative, and Bergson who holds Einstein to be wrong and simultaneity to be absolute. The author's conclusion is that both of them, as well as every other writer he mentions, are wrong, sometimes if not always. He tells us that Einstein's original exposition, published in 1905, is perfectly correct, but that he is a bad populariser and that his little book, "Über die spezielle und die allgemeine Relativitätstheorie gemeinverständlich," is wrong, and that poor Bergson was led astray through reading the popular account only. He then proceeds to give what he calls an improved and correct popular account, and throws in (page 185) the modest disclaimer: "In making this attempt I do not, of course, wish to put myself above Einstein."

Actually the author is floundering in the bog of his own misconception of Einstein's meaning, one of his mistakes being failure to distinguish when Einstein is engaged in overthrowing the classical theory and when he is stating the theory which is to take its place.

The contemplation of the second and third groups of metaphysicians compels us to conclude that in some cases the discussion is of empty words with no underlying reality, and that we shall be wise to exercise discretion in all cases as to the acceptance of the metaphysicians' conclusions.

Nor was any other conclusion to be expected. Consider the magnitude of the task the metaphysician undertakes. His aim is to fuse all knowledge into an intelligible whole. To do that he must first make himself acquainted with all knowledge. It is true that he needs only general principles and may ignore details, but even so the mass of knowledge at the present day makes it an enormous task. Moreover, that is not the worst, for he must keep abreast of developments in all subjects, and developments of importance are taking place to-day in many subjects. We can only admire his courage and leave him to it. D. B. M.

Folklore in India.

The Folklore of Bombay. By R. E. Enthoven. Pp. 353. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 14s. net.

MR. ENTHOVEN'S book will be welcomed by those who require a very full synopsis of the folklore of the Bombay area. He has gathered together a vast mass of items which he has classified under subject headings—such as worship of natural objects, tree- and snake-worship, spirit-possession, totemism and

animal-worship, evil-eye, dreams and omens, etc. Under each category he cites a large number of beliefs and practices, the material having been partly collected by himself and partly derived from the works of others, such as B. A. Gupte and Sir J. Campbell. The compilation of this material must have involved much labour and search. The value of such a "corpus" of facts is evident, and the volume will prove an important reference-work.

The facts are simply stated for the most part, without elaboration; and there is little attempt to diagnose and explain the underlying motives which have dictated the beliefs, rituals, and customs recorded. Such interpretation would have added much to the interest and usefulness of the book; but the author may, no doubt, have realised the difficulties attending any attempt to probe the "true inwardness" and origin of superstitious beliefs and practices. Natural reticence on the part of the natives, coupled, as it usually is, with actual ignorance of the original, and even the present significance of their observances, militates against accurate diagnosis on the part of the researcher, and satisfactory explanations are not easily found. Mr. Enthoven's long residence in India gave him opportunity for seeing below the surface, and his views upon the *raison d'être* of many of the, seemingly, more inconsequent practices and beliefs which he describes, would have been welcome. At the same time, it must be admitted that long residence is liable to instil caution, by revealing difficulties and pitfalls which are hidden to the tender-foot, and to cause the experienced Western student to realise how ill-equipped he really is to probe and analyse the mentality of Oriental peoples. Recognition of obstacles difficult to surmount may have acted rightly as a deterrent, and have induced the author to abandon the open, speculative game and to play for safety.

The comparative study of superstitions has done much towards suggesting explanations of folk-phenomena, and will surely lead to further results. The object of the author of this volume is, however, to deal with the subject from a descriptive and not a comparative point of view. The book makes available for the student an extensive, classified collection of *data*, concerning in the main a single, if extensive, area; and it has an intrinsic interest, as reflecting the culture-status of the people within that area. This collection of facts will be appreciated by the comparative folklorists and ethnologists, who can collate the local material with similar phenomena recorded from other regions, and can study the whole on a broader basis. The book would have had added value had the author given in all cases the sources whence the items of information were collected. References are, unfortunately, few, and it would have been of interest to

know the extent to which the author's own observations have played a part in supplying material for this interesting volume.

A useful appendix has been contributed by the late Dr. William Crooke, in the form of a *questionnaire* on folklore. This enumerates many of the chief topics upon which information is needed, and should prove of considerable service to those residents who are anxious to increase our knowledge of the peoples among whom they live. The field-student should be warned that, in pursuing his investigations, *direct questions* should be avoided at all costs. HENRY BALFOUR.

Our Bookshelf.

Geschichte der Rübe (Beta) als Kulturpflanze von den ältesten Zeiten an bis zum Erscheinen von Achard's Hauptwerk (1809). *Festschrift zum 75jährigen bestande des Vereins der Deutschen Zuckerindustrie.* Von Prof. Dr. Edmund O. von Lippmann. Pp. vi + 184. (Berlin: Julius Springer, 1925.) 12 gold marks.

PROF. E. O. VON LIPPMANN, Director of the Zucker-raffinerie, Halle, to whom we are indebted for such a vast quantity of accurate information upon the history of chemistry, has now written a book which will interest not only those engaged in the sugar industry, but also botanists, chemists, and agriculturists. It is unnecessary to say that this latest production is characterised by the same sound scholarship and exhaustive research which marked the "Entstehung und Ausbreitung der Alchemie."

The earliest mention of the mangold appears to be in the "Acharnians" of Aristophanes (455-388 B.C.?). It is described by Theophrastus in the "Historia plantarum," and was certainly cultivated by the Greeks. Among the Romans, again, the plant was well known and is mentioned by Cicero, Catullus, and others. Since species of Beta grow wild on the North African shores of the Mediterranean, it is possible that turnips and mangolds may have been known to the ancient Egyptians. Whether this is so or not, they were common in Egypt at the time of Alexander the Great (333 B.C.), and are often mentioned by the Alexandrian alchemists of the third to fifth centuries A.D.

In later times, turnips, mangolds, and beetroot were all widely cultivated, and Prof. Lippmann takes his story up to the beginning of the nineteenth century. Although he modestly says of his book, with Luther, *Exemplum vobis dedi ut plura faciatis*, he has obviously searched the available literature with great care.

E. J. H.

Coal and Civilisation. By Prof. Edward Charles Jeffrey. Pp. xvi + 178. (New York: The Macmillan Co., 1925.) 10s. 6d. net.

THIS work may be considered as consisting of two parts, namely, a description of coal, its origin and structure on one side, and the application of coal in the service of mankind on the other. The former is of great interest and contains much novel matter, as might be expected from so distinguished a botanist as Dr. Jeffrey. The second theme is, however, very indifferently handled and forms a sad contrast to the former. Dr. Jeffrey

has evidently failed to appreciate the real effect of coal upon the history of civilisation; thus he repeatedly urges that British supremacy in the eighteenth century was due to the application of mineral fuel to the smelting of iron, but entirely overlooks the far greater issue, namely, that almost simultaneously the steam engine was developed in Great Britain, thus for the first time pressing latent energy into the service of mankind, which had up to then been forced to rely upon kinetic energy only. The author's technical knowledge of the subject is also not so sound as it might be. For example, he states that brown coals are treated "by briquetting with suitable binding media," whereas the chief value of brown coal lies in the fact that it is capable of being briquetted without the use of a binder.

In respect of the structure of coal and of the plants that enter into its composition, the views of Dr. Jeffrey are important and instructive; it may, however, be suggested that he seems inclined to put too much stress upon the fresh-water origin of coals and to have somewhat neglected the evidence of marine conditions. It might have been expected that the Delta theory of Fayol would have received some attention; Dr. Jeffrey is a convinced supporter of the view that coal is the product of plant remains transported to the waters in which the organic matter was deposited, but scarcely deals effectually with evidence contradicting that view, such as that afforded by the existence of under-clays with stigmarian rootlets.

An Introduction to Psychology. By Prof. Hugh A. Reyburn. Pp. v + 324. (Cape Town: Maskew Miller, Ltd., n.d.) n.p.

THIS is an attempt to compress a protean subject into 316 small pages, and, on the whole, a successful one. The fact that a well-chosen and comprehensive bibliography of 52 works follows the 16 chapters shows that the author recognises that his "Introduction to Psychology" is an introduction and nothing more, but it is no mere summary of what is already known, being very definite as to points of agreement with, and dissent from, other authorities.

The introduction of new terminology, always to be feared when opening a work on psychology, is avoided, and where there would otherwise be the possibility of doubt as to the application of any term, the context renders the meaning intended unmistakable.

Prof. Reyburn defines his subject as "the science of immediate experience." He does not, however, deal with objective manifestations to the neglect of the subjective, but attaches a good deal of importance to introspection. All that is most valuable in modern psychological schools of thought has been utilised or incorporated, but the extremist views of Freud and the behaviourists are not supported. A fear is expressed in the preface that the section containing an account of the nervous system may prove too long, but a closer condensation than the succinct summary given would scarcely be possible. Indeed, an amplification of the paragraph dealing with the cerebral cortex would be a desirable addition to future editions. It is rather remarkable that in a work on psychology containing much clear reasoning and sound judgment, the terms reasoning and judgment are not given even an indical reference.

Isis: International Review devoted to the History of Science and Civilisation; Official Organ of the History of Science Society. No. 21, Vol. VII (i.), 1925. Pp. 168. (Soc. Anon. M. Weissenbruch, 49 rue du Poinçon, Bruxelles.) Annual subscription, 26s.

ALTHOUGH *Isis* has become the official organ of the recently founded History of Science Society, it is happily still edited by Dr. George Sarton, its originator. The present number maintains the high standard which has been set by its forerunners, and the width of its appeal may be judged from the fact that it includes contributions from Essen, Rome, Madison, Belgrade, Amherst, and Montpellier.

Two articles of special interest are those by Prof. A. J. Hopkins on "A modern theory of alchemy," and Prof. Émile Turrière on the history of glass-making in western and central Europe from the Middle Ages to the end of the eighteenth century. Prof. Hopkins's theme is that the alchemists, far from failing in their quest, were successful, since their conception of "gold" was very different from ours. "The reason why we cannot follow the alchemistic theory or look upon those conceptions with sympathy is that the alchemist, like the artist, was stressing the changeable Aristotelian qualities where we stress weight and fixed qualities. . . . The alchemist fitted theory to practice and succeeded far beyond the realm of probability. According to his definition of 'gold' transmutation *was effected*. The alchemist obtained what he wanted." Although this theory of alchemy is not so novel as Prof. Hopkins appears to imagine, it has never received proper consideration. Yet it obviously explains much that is obscure, and Prof. Hopkins is to be congratulated upon having set it forth so clearly and logically.

Narcissus: an Anatomy of Clothes. By Gerald Heard. (To-day and To-morrow Series.) Pp. 156. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1924.) 2s. 6d. net.

THREE mottoes face the table of contents of this book, two from "Sartor Resartus" and one from Michael Angelo. The analogies they draw between life and clothes, the body, and architecture and its products, are worked out in detail. The author takes the line that psychology having resolved to treat nothing in its province as insignificant, clothing, now regarded as unimportant, may be assumed to be of racial significance, as a phase of the evolution which started on new lines when man emerged. Mr. Heard regards both clothes and architecture as parallel manifestations of an evolutionary force, tracing them from the beginning of weaving and the use of woven wattle for walls in the neolithic age, through Egypt, Mesopotamia, Crete, the classical period and historical times, down to the ferro-concrete building of to-day and modern costume, where development apparently has ceased. Fanciful though the analogy may seem, it is perhaps not extravagant to assume that racial character manifesting itself in two media so entirely different may still exhibit a certain convergence in style so far as conditions allow. After a certain stage, however, the standardising, more or less, of all modern communities is unlikely to offer much play for racial individuality, however either clothing or architecture may develop.

Tales from Nature's Wonderlands. By Dr. William T. Hornaday. Pp. xii + 235 + 24 plates. (New York and London: Charles Scribner's Sons, 1924.) 12s. 6d. net.

FORTUNATE indeed are the children who can claim the author of this book as grandfather and exact from him, as a grandchild's privilege, the charming stories here published. The author has covered a wide range of subjects, from the origins of the American fauna to life in the deep sea, from the American mammoths to the lung fishes of Australia, from giant monster reptiles of Hell Creek to the penguins of the Antarctic Continent, from the forests and jungles of India and Borneo to the mountain crags of the Canadian Rockies and the ice-bound Polar Seas. In all he is equally happy, interesting and vivid, telling his story in simple compelling language well calculated to stir the imagination of children. It was a happy thought to publish these stories from Nature's book, so simple and so scientifically accurate, and we would wish, with Dr. Hornaday, that all our young people should become acquainted with them. The photographic illustrations are good, and materially help towards a proper understanding of the text.

Chambers's Encyclopædia: a Dictionary of Universal Knowledge. New edition. Edited by Dr. David Patrick and William Geddie. Vol. 6: Hume to Manche. Pp. iv + 872. (London and Edinburgh: W. and R. Chambers, Ltd.; Philadelphia: J. B. Lippincott Co., 1925.) 20s. net.

THE latest volume of this convenient encyclopædia maintains the high standard of the work. The articles have been revised or re-written, and many new articles have been added. References to books published within the last few months are not infrequently included. There is a liberal allowance of excellent coloured maps, besides a number of smaller black and white maps, and many illustrations and diagrams. The encyclopædia is to be completed in ten volumes.

Outlines of a Philosophy of Art. By R. G. Collingwood. (The World's Manuals.) Pp. 104. (London: Oxford University Press, 1925.) 2s. 6d. net.

IF this manual has a fault, it is not that it is ill-done but that it is done too well. The author has instilled into his account of art a complete philosophy of life. Perhaps it was impossible to separate the two, but it demands of the reader a more than usual concentration of his attention. On the other hand, any one who wants a clear and concise account of Croce's æsthetic doctrine will find it admirably presented in the first chapter.

Traité de psychologie. Par Prof. Georges Dumas. Tome 2. Pp. 1173. (Paris: Félix Alcan, 1924.) 60 francs.

THIS is M. Dumas' second volume of an extensive survey of recent work in psychology. Though named a treatise, it is in effect an encyclopædia. It is a collaboration of the leading French psychologists, each of whom has been invited to write a dissertation on the special subject matter of his own research. It is a valuable work of reference, with a detailed bibliography attached to each section.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Preliminary Note on the Transmutation of Mercury into Gold.

THE experiment on the transmutation of mercury was begun in September 1924, with the assistance of Messrs. Y. Sugiura, T. Asada and T. Machida. The main object was to ascertain if the view which we expressed in NATURE of March 29, 1924, can be realised by applying an intense electric field to mercury atoms. Another object was to find if the radio-active changes can be accelerated by artificial means. From the outset it was clear that a field of

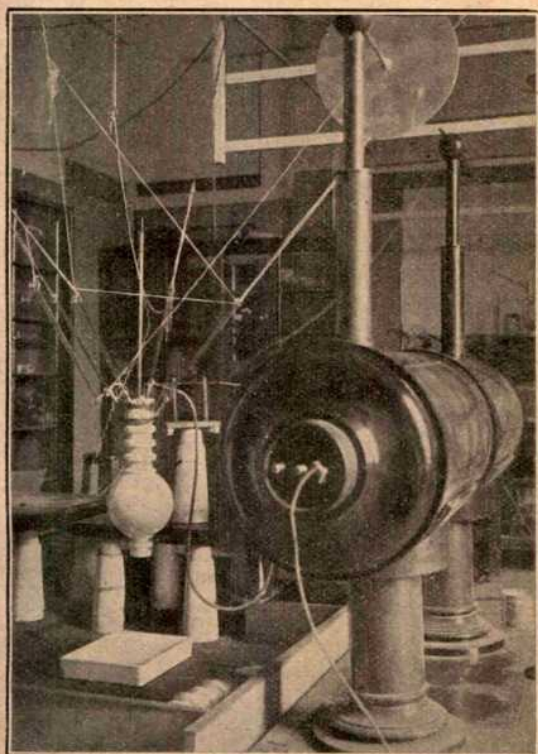


FIG. 1.—Apparatus for the electric discharge. Discharge vessel is supported on four glass insulators.

many million volts/cm. is necessary for the purpose. From our observation on the Stark effect in arcs of different metals (*Jap. Journ. Phys.*, vol. 3, pp. 45-73) we found that with silver globules the field in a narrow space very near the metal was nearly 2×10^8 volts/cm. with terminal voltage of about 140. The presence of such an intense field indicated the possibility of obtaining the desired strength of the field for transmutation, if sufficient terminal voltage be applied. Though the above ratio of magnification would be diminished with high voltage, the experiment was thought worth trying, even if we could not effect the transmutation with the apparatus at hand.

Fortunately an induction coil of 120 cm. spark length, made by Klingelfuss, was available for the purpose (Fig. 1). For keeping the terminal voltage between the electrodes sufficiently great with a short

spark gap, the discharge was conducted in paraffin oil, in which a potential difference of about 15×10^4 volts/cm. can be maintained. With iron and purified mercury as electrodes, the discharge appeared at first as arcs, and the spectrum was continuous; it gave rise to abundant production of gases and carbon particles from the oil; the mercury gradually turned into fine globules, until the oil and mercury were mixed into a black pasty mass. We cannot definitely say whether the intense field observed during the experiment on the Stark effect was present during the discharge or not, but it is probable that mercury atoms have been acted upon by strong electric force during the violent bombardment, as the discharge is of an analogous nature. Continuing the discharge for about four hours, the product was examined chemically for gold by the test of Cassius'-purple; the result was decidedly positive. This experiment was performed on September 15, 1924; on succeeding days experiments were repeated, and two days after, Mr. Yasuda, an expert in gold assaying, showed us minute gold specks extracted from the black mass obtained in the experiment of the previous day. Grave doubts were, however, expressed by critics as to the purity of the mercury and also as to the possible presence of traces of gold in the chemical laboratory, due to frequent treatment of the metal.

To clear away these doubts, the mercury to be used in the experiments was first purified by ordinary chemical means, and then subjected twice or thrice to vacuum distillation, care being taken not to raise the temperature above 200° . The mercury, oil and chemical reagents used in the experiments were carefully examined by making blank tests. A room in the physical laboratory was allotted to the chemical experiments. Succeeding experiments confirmed the result, but the glass vessel was too fragile to pass the heavy condensed discharge, and it exploded during the process. Bushing insulators were tried, but the tube was too narrow, and the discharge passed into the walls. A discharge vessel of about 2 litres capacity with walls of 2 cm. thickness, provided with a long neck and a short tail for inserting the electrodes, was designed and made ready for experiment in the beginning of May. During these intervals, minor tests were made with the porcelain flask on the mode of discharge, the oil to be used for the process, the material of one of the electrodes, and easy means of detecting the presence of gold.

As we found in our investigation on the Stark effect, it is always advisable to insert condensers in the discharge circuit. We used bushing condensers of many glass plates with thin lead plates between them, the total capacity being about 0.002 microfarad. As the discharge potential is very high, the condenser plates are apt to break, and must be so large that discharge between the end plates does not take place in air.

As iron contains many impurities, we found that tungsten wire, free from thorium oxide, which we obtained through the courtesy of the Tokyo Electric Company, is the best on account of the small corrosion during the discharge.

As to the method of testing, the formation of ruby glass is delicate and in most cases accompanied by the separation of gold particles at the centre or outside boundary, which can be observed with a metallographic microscope, by using reflected light.

A special distilling flask was designed for the purpose of separating carbon, oil, and mercury from the residue in the discharge vessel, after bombarding the mercury for 10 to 15 hours. Paraffin, kerosene, and transformer oil can be used, but the last seems to be the most suitable.

The gold obtained from mercury seems to be mostly adsorbed to carbon. Ruby glass is formed by heating small pieces of glass with the carbon; in the process now used it is formed in numerous spots on the walls of the distilling flask by repeatedly heating it to about 600° . We have often separated mercury by washing the oil with benzene and ether, and after separating it from carbon by centrifugal separator, distilled it in vacuum and examined the

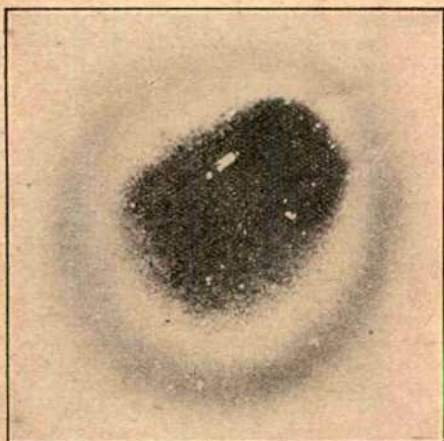


FIG. 2.—Ruby glass by transmitted light. $\times 150$.

residue, which generally contained no gold, but a minute quantity of white metal, which may probably be another product of heavy discharge; it was, however, too small to be tested chemically.

The accompanying illustration (Fig. 2) shows a spot of ruby glass photographed with transmitted light and magnified 150 times. The central dark portion contains gold particles distributed as shown in Fig. 3 taken with reflected light and magnified

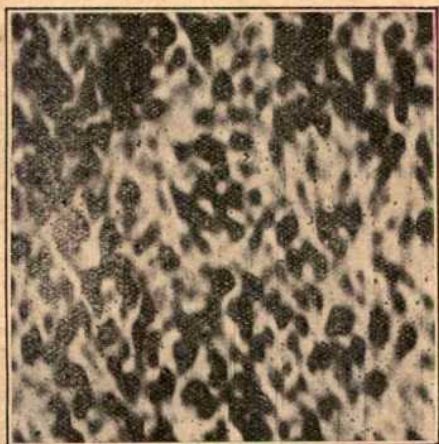


FIG. 3.—Ruby glass by reflected light. $\times 2500$.

2500 times. It represents only a small part near the boundary of the central spot. The white ring is greenish blue, and the lightly shaded one is rosy; these colours are characteristic of gold colloids. Numerous spots of this kind are obtained in the bottom of the distilling flask during the after-treatment of a mixed mass of carbon and mercury after heavy condensed discharges. Sometimes ruby glass is apparently covered with a thin film of gold; on microscopic examination it is found to consist of fine particles of gold very densely distributed.

The primary current in the induction coil in such experiments ranges from 25 to 30 amp., and the spark length in air is more than 1 m.

Probably we could produce the same effect by using lower voltage, if sufficient capacity were inserted, but the resistance of the vessel is not great enough to withstand the heavy discharge, especially when carbon and mercury are intimately mixed together. The construction of a proper discharge vessel seems at present to be a difficulty in getting an amount of gold sufficient to determine its atomic weight. Which of the isotopes of mercury is changed into gold can perhaps be inferred from the atomic weight. Spectroscopic examination will be started so soon as we can obtain sufficient material for the purpose.

The process taking place may be looked upon as due to commotion in the nucleus by intense electric force. If we assume that Coulomb's law ceases to hold within the nuclear boundary, the positively charged protons form a compact core, and the electrons within the boundary surround it. On applying an external electric field the motion of the core is opposite to that of the electrons, so that if the field be sufficiently strong, it is possible that some of the electrons may pass out of the nuclear boundary, and if the core be not very stable, some of the protons constituting it may get out. The commotion thus introduced by the external force will have some resemblance to radio-active disintegration, which must be attributed to the internal commotion of the nucleus. An experiment was made with ferro-uranium, to see if the radio-active process cannot be accelerated by applying a strong field, but owing to the ionisation it was difficult to maintain the field for a sufficient length of time. An investigation of the process of accelerating the disintegration must, therefore, be reserved for future experiments.

The experimental procedure here sketched cannot be looked upon as the only one for effecting the transmutation; probably different processes will be developed and finally lead to industrial enterprises. At present, there is no prospect of producing gold economically from mercury. Experiments with various elements may lead to different transmutations, which will be of significance to science and industry. Meagre as is the result, I wish to invite the attention of those interested in the subject so that they may repeat the experiment with more powerful means than are available in the Far East.

H. NAGAOKA.

The Institute of Physical and Chemical Research,
Komagome, Tokyo, May 26.

The Quantum Explanation of the Zeeman Triplet.

IN his letter published in NATURE of June 27, p. 978, Prof. W. M. Hicks raises some interesting points in connexion with the quantum theory of the simple Zeeman effect. As Prof. Hicks points out, the theorem of Larmor's usually taken as the basis of the theory does not define in any manner the relation between the orbits on which the rotation is superposed in the presence of the field on one hand, and the corresponding orbits before the imposition of the field on the other. The supposition that these two sets of orbits are identical is, therefore, in no way justified on the basis of Larmor's theorem alone. It can, however, be shown from purely classical considerations (see G. A. Schott, "Electromagnetic Radiation," Cambridge University Press, 1912, §302, p. 317) that, to the first order in terms involving the field, the two sets of orbits are identical. Schott's proof takes into consideration the induction

forces which act on the moving charges during the period of establishment of the field, whereas Larmor's theorem confines itself to the so-called Coriolis forces which, as Prof. Hicks points out, act transversally on the moving charges, and hence cannot alter their energies.

Prof. Hicks proves in a simple case that the application of the Wilson-Sommerfeld quantum conditions to the Bohr hydrogen atom with reference to fixed axes (instead of the special rotating axes employed in the usually accepted theory) leads to no Zeeman effect at all as a first approximation. A more general proof of this was given in a paper of mine about two and a half years ago (Roy. Soc. Proc., A, vol. 102, 1923, p. 529) in which I also put forward an alternative theory of the simple Zeeman effect which seems to me to answer Prof. Hicks's purpose. The theory is based on a slightly extended form of the quantum conditions which was first suggested by Prof. William Wilson (Roy. Soc. Proc., A, 102, 1923, p. 478), namely,

$$\oint_0 \pi_i dq_i = n_i h, \quad (i = 1, 2, \dots)$$

where

$$\pi_i = p_i + e A_i,$$

p and q being the usual Hamiltonian co-ordinates, e the charge on the particle in question, and A the generalised magnetic vector potential. These conditions are applied both in the absence and in the presence of the field, thus defining the orbits and their energies in both cases, and the frequencies are then obtained from the energy relation $\Delta W = h\nu$. It is also shown that the relation between corresponding orbits defined by the extended conditions (*i.e.* orbits for which the quantum numbers are the same) is in complete accord with Schott's theorem; in fact the latter is derived as a necessary consequence of the quantum conditions themselves.

A. M. MOSHARRAFA.

The Manor House,
Alphington, near Exeter, June 28.

THE objection of Prof. Hicks to the use of Larmor's principle (NATURE, June 27, p. 978) is well founded, but the Zeeman triplet effect can be made to fit into the quantum theory by keeping strictly to dynamical principles. The phase-integral $\oint p dq$, for a variety of reasons, is, for the case of a magnetic field, to be replaced by $\oint (\delta L / \delta \dot{q}) dq$, where L is the Lagrangian function. For the hydrogen atom

$$L = \frac{1}{2} m (\dot{r}^2 + r^2 \omega^2) - \frac{1}{2} H e^2 \omega / c + e^2 / r.$$

Hence, on quantising,

$$m r^2 \omega - \frac{1}{2} H e^2 = n h / 2 \pi.$$

From this, for radial quantisation,

$$m^2 r^2 + n^2 h^2 / 4 \pi^2 r^2 = 2 e^2 m / r - 2 m C',$$

where $C' = C + n h e / 4 \pi m c$, $-C$ being the energy and H^2 being neglected. Hence the "permitted" value of the energy is

$$- (2 \pi^2 m e^4 / h^2) / (n + n')^2 + n h e / 4 \pi m c,$$

where n, n' are the azimuthal and radial quantum numbers.

ARTHUR W. CONWAY.

Abbeyview, Dalkey, Co. Dublin,
June 27.

The Oogenesis of Lumbricus.

IN a letter to NATURE (June 27, p. 979) Prof. J. B. Gatenby objects to certain comments upon his work made recently by Mr. L. A. Harvey in a paper on yolk-formation in the earthworm (*Q. J. M. S.* 69, p. 291). Mr Harvey is a student working in this department and it is on his behalf that I wish to protest against the tenor of Prof. Gatenby's letter.

It is quite evident that Prof. Gatenby has not comprehended clearly the contents of Mr. Harvey's paper; for his letter contains misstatements, and these may do a considerable amount of harm unless speedily contradicted.

Prof. Gatenby accuses Mr. Harvey of having been discourteous in saying that a glance at a paper of his (Prof. Gatenby's) summarising what is known about the formation of yolk shows that "really very little is known" on the subject. Mr. Harvey was perfectly justified in making this statement—it is simply a statement of his opinion—and on this point I am in complete agreement with him. The fact that Prof. Gatenby disagrees with the statement does not make it discourteous. The paper referred to, Prof. Gatenby complains, is an "old one." Its actual date is 1920, and if the advance since then is represented in Dr. Brambell's paper (1924) on "Yolk," to which Prof. Gatenby refers, it can safely be said that any advance made has been extremely small.

The remarkable objection is then made that Mr. Harvey, in studying yolk-formation in *Lumbricus*, is not justified in inferring any conclusions as to the similar process in *Limnæa*—a form studied by Prof. Gatenby. He gives no reason in making this statement. However, he previously refers to a paper by a student of his as containing an account of *Molluscan* oogenesis. Actually it deals with two forms and those both gastropods, and hence any general conclusions drawn must have been inferred from the study of those two forms.

Prof. Gatenby suggests that before criticising his work Mr. Harvey should have repeated it. While I admit that repetition might be desirable, it is obvious that Prof. Gatenby has failed to grasp Mr. Harvey's criticism, which is, not that his observations are at fault, but that his deductions are. This is made perfectly clear on p. 292.

Prof. Gatenby's next point is that it was unfortunate that the egg of *Lumbricus* was chosen for the study of yolk-formation, as it contains no "real yolk." This is incorrect. Yolk is present in the egg, and the criteria used for the recognition of that yolk were those advocated by Prof. Gatenby himself. This is fully explained on p. 299. Further, Prof. Gatenby objects that *Lumbricus* is a "special atypic annelid" and yet refers to *Saccocirrus* (apparently) as a typical annelid.

It is the static conception of the cell to which Mr. Harvey objects. He regards it essentially as a dynamic concern—an equilibrium system in which the constitution of each constituent is a function of its surroundings—and because of this he considers that the technical methods and the reasoning adopted in modern cytological investigations into the question of yolk-formation are wrong. If Prof. Gatenby had read more carefully the introduction to Mr. Harvey's paper he would have grasped this, and, in that event, it is to be hoped, would not have written his letter.

H. GRAHAM CANNON.

Zoology Department,
Imperial College of Science,
South Kensington, July 2.

Transmission of a Rosette Disease of the Ground Nut.

THE important part played by insects in the dissemination of the virus diseases of plants is now recognised, and experimental proof of transmission by particular insects exists in a number of cases. As a result of investigations during the past season, we are able to add one more to the list of those diseases of which the insect vectors are known.

During recent years the cultivation of the ground nut or peanut (*Arachis hypogaea*, L.) in parts of South Africa has been seriously handicapped by outbreaks of a disease locally known as "rosette." The leaves of an affected plant are small, twisted and closely crowded, owing to the non-elongation of the internodes of the stem, giving the plant a bunched or rosetted appearance. These leaves are generally yellow, but in many cases show definite mottling. No seed is set by a plant diseased at an early stage of growth; and the yield is materially reduced by late infection.

We believe this rosette disease to be identical with the East African "krauselkrankheit" of Zimmermann ("Der Pflanze", 1907 and 1913), with the Javan "krulziekte" of Rutgers (Dept. Landbouw, Nijv. en Handel in Nederl. Indie, Meded. v/h Instituut voor Plantenziekten, 1913), and with the "bunching" or "clumping" recorded from West Africa and India.

All investigators of this disease failed to attribute it to any parasitic organism or in fact to any definite cause, and its nature remained little understood. Zimmermann (1907) directed attention to a similarity between this disease and tobacco mosaic; more recently, the comparison was rendered the more obvious by extensions in our knowledge of the plant virus diseases, so that pathologists generally assumed that the peanut rosette disease belonged to the virus group. Support to this view is now afforded by experimental transfer of the disease. Work carried out under our direction at Pretoria and independently at Durban has demonstrated the ability of *Aphis leguminosae*, Theo., to transmit the disease. In these experiments aphids, removed from rosetted peanut plants, were allowed to feed upon a single mature leaf of a healthy plant, suitably protected from the feeding of any other insects. The characteristic rosette symptoms appeared afterwards in the young leaves of a large proportion of these plants. Control plants, receiving identical treatment but protected from the feeding of any insects, remained healthy.

During the course of this work, collections were made of all the suctorial insects occurring upon diseased peanuts in the field. Tests of more than two hundred individual jassids and fulgorids belonging to at least eight species afforded no single infection of the experimental plants.

H. H. STOREY.

Natal Herbarium, Durban.

A. M. BOTTOMLEY.

Division of Botany, Pretoria.

X-ray Stimulation of Phosphorescence of Fused Silica.

WITH reference to the recent correspondence in NATURE on the properties of silica, the following experiments on its phosphorescence after exposure to ultra-violet and X-rays may be of interest. In the course of experiments to test the supposed fluorescence or phosphorescence of castor oil after exposure to ultra-violet light, it was found, working independently, that a photographic plate was blackened when exposed to the oil if the vapour were allowed to come in contact with it. If, however, the vessels containing the oil were carefully sealed no blackening was obtained, even when the oil had been previously exposed to ultra-violet light. The vessels containing the oil were sealed glass jars having polished natural quartz lenses as windows, the exposure to ultra-violet radiation being carried out in these vessels.

A fused silica weight thermometer exposed to the X-rays from a "Shearer" tube for periods varying from half an hour to several hours, and then placed

in contact with a photographic plate, produced considerable blackening whether containing oil or not, the fused silica being responsible for the whole of the effect, since oil exposed to X-rays, and then transferred to a quartz vessel after treatment, would not produce blackening.

The polished lenses of natural quartz previously employed could not be stimulated with X-rays or ultra-violet light to actinic phosphorescence, but experiments have shown that various specimens of fused silica can be made to phosphoresce, and, moreover, may be seen in a dark room to fluoresce a faint green under the direct action of the X-rays, the luminosity apparently ceasing with the cutting off of the radiation.

The silica continues, at room temperature, to give off radiations for periods up to three weeks or a month after the original exposure to X-rays, but the phosphorescence is removed by heating to redness for two minutes.

F. L. HOPWOOD.

W. V. MAYNEORD.

Physics Dept.,
Harvey Laboratories,
St Bartholomew's Hospital, E C.1.

The Sound of Lightning.

SINCE my letter on the above subject in NATURE of May 23, several other instances have been brought to my notice. Mr. W. H. Dines has heard the sound six times certainly, and probably more; Mr. J. S. Dines has heard it once, as has also my brother, Capt. A. L. Cave, in London, when he was indoors; two other correspondents also write to say that they have heard the sound, one of them three times. But perhaps the most remarkable case is that given in the *Marine Observer* for July (page 112); Capt. J. Burton Davies of s.s. *Hurunui* reports that from 10 P.M. on July 30, 1921, to 3.45 A.M. on July 31, when in about lat. 38 N. and long. 71 W., "a terrific electric storm was playing about the ship. . . . On three occasions the officer of the watch and myself were momentarily completely dazzled by flashes, and it appeared that immediately before the flash we heard a tearing noise as of canvas being ripped violently; in fact, after the first of these flashes I caused the quartermaster to inspect the boat covers on boat deck to see if any were torn. This noise interested me very much." The fact that the noise was heard before the flash seems to indicate that it may have been caused by a brush discharge. In any event, it proves that the noise must be real, and not an illusion like the rushing noise that some have imagined they have heard when watching a bright meteor, or the rustling sometimes attributed to the aurora.

C. J. P. CAVE.

Stoner Hill, Petersfield,
July 2.

Ether Drift and the Relativity Theory.

IN reply to Prof. Eddington's letter in NATURE for June 6 (vol. 115, p. 870), it will be enough to state that the type of ether motion alluded to in my first letter on this subject is, in spite of appearances, strictly *irrotational*. For all details and the literature of the subject the reader may be referred to my paper on "Stokes-Planck's Aether" in the *Phil. Mag.* for February 1920, p. 161. The irrotationality of Lorentz's solution to which the said motion corresponds is there sufficiently emphasised.

LUDWIK SILBERSTEIN.

Rochester, N.Y.,
June 29.

The Royal Observatory, Greenwich.

THE Royal Observatory was founded in the reign of King Charles II. to assist in the solution of the important and difficult question of determining longitude at sea. The use of the method afterwards known as "lunars" had been suggested. As the moon moves round the sky in a month, its position among the stars changes rapidly: if, then, an almanac can be prepared giving the position of the moon among the stars according to the time of some fixed place, say Greenwich, the navigator can by observation of the moon determine the Greenwich time. It is an easy matter to determine his local or ship time, and the difference gives the longitude. In the seventeenth century the movement of the moon was not known with nearly sufficient accuracy for this method to be available, and even the positions of the fixed stars were very imperfectly charted. The Royal Observatory was founded to remedy these defects, and Flamsteed, the first Astronomer Royal, was charged to make observations for "rectifying the tables of the motions of the heavens and the places of the fixed stars so as to find out the so much desired longitude at sea, for perfecting the art of navigation."

At the suggestion of Sir Christopher Wren the site for the Observatory was chosen on a hill in Greenwich Park. A grant of 500*l.* was made by the King, bricks were obtained from a disused fort at Tilbury, and the Observatory was built according to the design of Wren by Sir Jonas Moore, Master-General of the Ordnance. The foundation was laid on August 10, 1675, and the building completed in the following year.

The Rev. John Flamsteed was appointed Astronomer Royal at a salary of 100*l.* a year, but he was not provided with any instruments. He brought with him an iron sextant of 6 ft. radius, and Jonas Moore lent him a smaller one and two clocks. The use of clocks as part of an observatory equipment dates from about this time. Flamsteed made repeated appeals, but in vain, for money to erect an instrument in the meridian, which, he was convinced, would give greater accuracy and was essential for referring the position of the stars to the equinox. In 1683 he erected a mural circle at his personal expense, dividing it with his own hands. This instrument was not very satisfactory, but in 1688, as he was in better circumstances, he had a larger one constructed for him by Abraham Sharp, at a cost of 120*l.* Sharp was his friend and assistant, and the two worked together for several years, determining the position of the equinox, the obliquity of the ecliptic, and the positions of sun, moon and stars. The "*Historia Coelestis*," which contains an account of his methods and results, was published partly by himself and completed after his death by Abraham Sharp in 1725. It may be noted that Flamsteed was one of the first astronomers to use telescopic sights in his observations, as he was one of the first to make lunar observations. His observations were a great advance on those of previous astronomers, though they are now of little value.

On the death of Flamsteed in 1719, he was succeeded by Halley, the friend of Newton, who secured the publication of the "*Principia*." He rendered many services to science, but is best known for his prediction of the return of the comet to which his name was afterwards given. When Halley came to the Observatory, it was without instruments, as Flamsteed's executors had claimed those which he had used. In 1721, Halley installed a small transit instrument. Although the design is open to criticism, the instrument is of interest as the earliest specimen of a very important type. In 1725 he had a large iron mural quadrant constructed by Graham. With his instrument he made many observations, particularly of the moon.

Bradley succeeded Halley in 1742. From his observations at Wanstead he had discovered the aberration of light in 1729. He continued his observations for many years and announced the discovery of nutation of the earth's axis in 1748. With the help of his nephew, who was appointed his assistant, he commenced observations with Halley's instruments. He applied for funds for new instruments, and on the recommendation of the Board of Visitors, seconded by the Council of the Royal Society, was granted 1000*l.* by King George II. With this money he obtained an 8 ft. brass quadrant, and a transit instrument of 4½ ft. focal length and an object glass of 2.7 inches. These were both made by Bird. He also obtained a clock by Shelton, which is still in use at the new magnetic station at Abinger.

With these instruments, Bradley laid the foundations of modern astronomy of position. His skill in the design and use of his instruments rendered his observations far more precise than those of any of his predecessors. The observations were collected and reduced after his death by his friend Hornsby. They were later re-reduced by Bessel in his "*Fundamenta Astronomiae*," and again late in the nineteenth century by Auwers. Our present knowledge of the direction of the sun's motion in space, and the existence of two star streams, is largely dependent on proper motions derived by comparing later observed positions of stars with those found by Bradley.

Bradley's successor, Bliss, lived only two years after his appointment and was succeeded by Maskelyne in 1764. Maskelyne had been sent at Bradley's suggestion to observe the transit of Venus at St. Helena in 1761. He made practical application during his voyage of methods of determining longitude at sea by lunar observations, and soon after his return published the "*British Mariner's Guide*," the forerunner of the "*Nautical Almanac*," which commenced in 1767. These works gave precise directions and presented astronomical data in the simplest and most suitable forms for their application to navigation. During the forty-four years of his tenure of office, he was very assiduous in the observation of sun, moon, planets and a small number of the brighter stars, being specially attracted by the problem of determining the position at sea, to which the Observatory owed its origin. His expedition to Schiehallion to determine the mean density of the earth was made in 1774. Towards the end of his reign he had the mural quadrants of Graham

and Bird needed to be replaced. Pond, from observations made at Westbury in 1801-1806, had shown the advantage of using a complete circle instead of a quadrant. Maskelyne gave instructions to Troughton for the construction of an instrument of this form, but did not live to see the completion of this beautifully designed and excellently divided circle.

On the death of Maskelyne in 1811, Pond was appointed Astronomer Royal. The mural circle made by Troughton, and the transit instrument made by the same great artist in the year 1816, were the greatest improvements in astronomical instruments since the time of Bradley. A second circle by Jones was added in 1825. Pond introduced the method of observing stars by reflection in mercury with one instrument while they were being observed directly with the other. On the following night the rôle of the two instruments was changed. Pond's observations were of a very high order of accuracy, so much so that Chandler traced in them the small changes caused by variation of latitude. His Catalogue of 1112 stars was a most valuable contribution to the accurate determination of stellar positions. Pond was also able with these instruments to show that several alleged discoveries of parallax of stars of the order of about 1" were incorrect. Another benefit which the Observatory derived from Pond was an increase in the number of assistants from one to six, resulting in a considerably increased output of observations.

Airy succeeded Pond in 1835 and retired from his post in 1881 at the age of eighty. His contributions to optics, tides, metrology and many practical questions are outside the scope of this article. He introduced into the Observatory very orderly and business-like methods of reduction of observations and their regular and prompt publication. Of the new instruments which he installed, the transit circle erected in 1851 has been the most valuable. Its use led to a great increase in the number of observations. He introduced the use of registration on the chronograph, a method invented in the United States. He also introduced the system of telegraphic transmission of time daily from the Observatory to the General Post Office for distribution over Great Britain. The great equatorial, erected in 1860, with a 12.5-inch object glass by Merz, was for a time the largest refractor in England. Airy's reduction on a uniform system of the lunar and

planetary observations made by his predecessors since the time of Bradley was a great contribution towards the formation of accurate tables of the movements of sun, moon and planets. He extended the scope of the Observatory by the introduction of magnetic and meteorological observations.

Christie succeeded Airy in 1881 and retired in 1910. During his tenure of office, photographic observations became a part of the regular work of the Observatory. The daily photography of the sun, and measurement of the position and size of the spots, was actually begun in Airy's time but was developed considerably by Christie. A share was taken by Greenwich in the photographic chart and catalogue of the heavens, and for this purpose the astrographic telescope was obtained. Additions to the equipment were made in the 28-inch visual equatorial, used mainly for observations of double stars; in the altazimuth, essentially a transit instrument which can be placed in any azimuth; and in the Thompson equatorial, consisting of a 26-inch photographic refractor and a 30-inch reflector, the gift of the eminent surgeon Sir Henry Thompson. The large increase in the buildings and instruments made in Christie's time were very necessary for the Observatory to maintain its high position. A great extension took place in the output of the Observatory in meridian astronomy. The part assigned to Greenwich in the astrographic chart and catalogue was carefully carried out. A thorough determination was made of the solar parallax by observations of Eros. Valuable series of double star observations were made with the 28-inch telescope, and the two telescopes of the Thompson equatorial were employed on a variety of problems.

In conclusion, it may be truly said that the original intention of the founders of the Observatory has been carried out consistently for 250 years. The pursuit of the practical problem of the determination of longitude has involved long series of observations which have contributed very largely to our knowledge of the movements of sun, moon and planets. At the present time a larger share is given to questions of purely astronomical interest, but the practical applications of science are still interwoven with them in observations of position of sun and stars, the distribution of time, the care of the Navy chronometers and the compilation of magnetic charts. F. W. D.

Problems of the Rhone Delta.¹

By R. D. OLDHAM, F.R.S.

IV.

WHEN, in 1711, the Rhone broke away from its former course to the sea, it more and more adopted the new channel until, in 1724, the older one was definitely closed to navigation; the river, following the course it still maintains, had established its channel to the sea-face, and in 1725 the town of Arles complained of the difficulties of the new mouth, where extensive sand-banks had formed. The river, in fact, having reached the open sea, was subject to conditions which are described in reports of the difficulties of the river, where the deposit of silt, when

reaching the sea, combined with the effect of the waves in sorting and casting back the coarser grained material, together with the absence of any tidal scour, led to the formation of low sand-banks, known as *they*, barely emerging from the water when the sea-level was low, and submerged when it was raised by a river flood or an onshore wind. The main channel of the river was blocked by a well-defined bar, which might

¹ Continued from p. 5

narrow channel practicable, and for 120 days in the year the passage was too dangerous to allow of any vessel entering or leaving the river; even when the channel was otherwise clear, vessels might find that it had shoaled too much to admit them, and have to tranship their cargo into lighters of shallow draft.

Various attempts were made to overcome these difficulties. The first was the construction of a canal from Arles to Port de Bouc, but the dimensions of the canal were too small to render it serviceable. The next scheme was to restrict the river to a single narrow outlet, in the hope that the scour of the current would

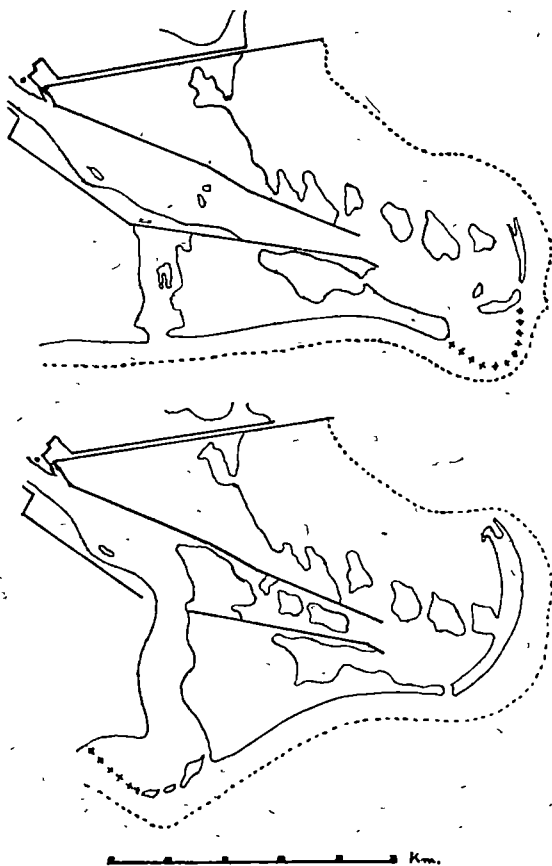


FIG. 5.—Mouth of the Rhone in 1893 and 1913. Dotted line marks the contour of 5 m. depth of water.

maintain a deep channel, and in 1852–55 embankments were carried along both banks to the mouth, the last of the lateral outlets being closed in 1856. At first, success seemed to have been attained, the channel deepened to 12 feet, but in a couple of years a new bar had formed, further out, and the channel shallowed to its old depth of 4 to 6 feet. This plan having proved a failure, it was decided to cut a ship canal from the Gulf of Fos and form a port on the river near the Tour St. Louis, and by 1871 the port and canal, with its locks, were completed. This proved a modified success, the Port of St. Louis established itself as one of the principal of the minor ports on the Mediterranean coast of France, and would doubtless have attained greater prosperity but for malaria, with which this part of the delta is infested.

Meanwhile the mouth of the Rhone had been advan-

cing south-eastwards at a rate of about 60 metres a year, and threatened to block the fairway to the Port of St. Louis, so it was decided to reopen the Grau de Roustan, which had been the principal lateral outlet of the river on the western side. In 1893 the embankment with its stone revetment was removed, and a narrow cut opened to the river through the land which had been formed since the embankment was made. This cut, as was expected, was widened by the river, which rapidly adopted this channel as its main outlet to the sea, the previous main channel becoming more and more blocked with sand-banks. At the end of twenty years a complete change had come over the mouth of the Rhone. The channel of 1893 had been almost completely filled up, only a narrow and shallow channel remaining; the low *theys*, the bar at the mouth, had been washed away by the sea, and a continuous barrier of dry sand, crowned with sand dunes, formed at about 700 metres behind the previous position of the mouth. The old Grau de Roustan had become the sole outlet of the river, which had built up new land to 1200 m. in advance of the old shore-line, and the mouth was blocked by a row of *theys* and a bar, like that which had formerly blocked the mouth of the river, and such as will always be formed where a silt-bearing river enters an almost tideless sea.

It is of some interest to compare this description of the conditions at the mouth of the Rhone, in the nineteenth century, and the measures undertaken to overcome the difficulties, with the accounts which we have of the campaigns of Caius Marius in 103–102 B.C., in the course of which he encountered the same difficulties and adopted similar measures to overcome them. Plutarch, in his life of Marius, says that the mouth of the Rhone being barred and almost filled up with sand and mud, the passage became narrow, difficult, and dangerous for the ships which brought provisions; so Marius, bringing his army, drew a great trench and, by turning a great part of the river, brought it to a convenient point on the shore where the water was deep, and this still retains the name it took from him. To this account Strabo adds that, after the defeat of the barbarians, Marius gave the canal to the people of Marseilles, who derived great revenue from tolls on ships passing along it, notwithstanding the entrance continued difficult to navigate, on account of the deposits and the flatness of the country, so that in foul weather the land could not be discerned, even when one was quite close.

The account which these writers give of the entrance to the Rhone shows that conditions were the same as in the nineteenth century, and suggests that what Marius did was analogous to the solution arrived at some 2000 years later, when the St. Louis canal was dug; and Strabo's account of the difficulties which arose, in later times, is matched by the formation of sand-banks, and a bar, across the Grau de Roustan, when that became the main channel of the Rhone. The digging of a canal a mile and a half long, or very likely less, would not have been too great a work for an army to undertake in the time at his disposal; once dug, access would be made easier for a while, but in course of time, as the river abandoned its old course and adopted the new one, all the difficulties and dangers of the entrance to the river would reappear. That no trace of this canal

remains is not to be wondered at; the river continued to bring down silt and extend the delta for eight centuries after it had been dug, and then came the subsidence which caused any trace of the work of Marius, necessarily lying near sea-level, to be buried under twelve to fifteen feet of silt or water.

During the last two centuries, in which the river has been building up the projection from the old sea-front of the delta, which has reached a length of about 9 kilometres, and has added nearly 40 square kilometres to the area of the delta, changes of a different character had been taking place farther west. The river, during the period in which it had flowed in the channel of the Vieux Rhône, had built up a prominence of some four or five kilometres, but as soon as the course of the river had changed, and the transport of fresh material had ceased, this prominence was attacked by the waves of the sea, and rapidly removed. Opposite the Farman lighthouse, the recession of the sea-front amounted to about 4.5 kilometres between 1710 and 1870, after which equilibrium seems to have been nearly established and recession became slow. The material removed from this part of the coast was mainly swept to the westwards, where part of it went to form the projection of the Pointe de Beauduc, but part was drifted round the point, to form the continuous barrier and sandy beach which borders the Golfe de Beauduc. Maps of the seventeenth and early eighteenth centuries show no trace of this, the Pointe de Beauduc is not indicated, and the Golfe is bordered by an archipelago of islands, separated by channels, open to the sea and penetrating inland to the Étang de Vaccarès. The date at which these conditions were altered, by the formation of a continuous beach and barrier along the coast, cannot be determined with precision, but in the Cassini map, constructed in the 'seventies of last century, the barrier is shown, and the sea-face is almost as mature in form and outline as on the most recent maps, so we may put the transition, from the immature to the mature form of the existing sea-coast, as having taken place round about the close of the eighteenth and the commencement of the nineteenth centuries.

This completes the cycle of changes which this region of the Rhone delta has undergone, since definite information commenced with the advent of the Romans. At the outset, the extent and outline was not materially different from that of the present time, but the land stood about fifteen feet higher above sea-level than nowadays, the extensive salt lakes and marshes were all dry land, and the Camargue was a fertile, populous, and prosperous region. Along the sea-coast there were probably lagoons, separated from the sea by a continuous barrier, sand dunes and sandy beach, which swept round the coast in smooth and even curves, characteristic of a mature coast-line. At the mouth of the river, which lay farther west than the present mouth, a projection had been formed by the alluvium brought down by the river, exactly analogous to that which has been built up along the present channel. These conditions continued during the rise and fall of the Roman dominion in Gaul until, in the eighth and ninth centuries, a subsidence of the land took place, by which not only were the low level deposits along the coast and at the mouth of the river plunged beneath the sea, but a larger part of the higher ground behind them was also brought below sea-level. The matured coast-line disappeared and was replaced by the immature condition of an archipelago of islands, and the river, instead of debouching in the open sea, ended far inland in a land-locked inlet of shallow water. Then, for some eight centuries or so, the river was occupied in filling up the submerged areas of the delta, and in pushing forward its mouth until, about the middle of the seventeenth century, it again reached the sea-front, and about a century and a half later the continuous barrier and beach, with the curved outline of maturity, was again established. Along the sea-coast the delta had resumed the general type, and approximately the outline, of earlier times, but, in the interior, large areas of what was then dry land are still occupied by salt water lakes and marshes, which have been protected, by accidents of surface configuration, from the deposits of the river, and still remain much as they were left at the close of the period of subsidence.

Evolution and Intellectual Freedom.

SINCE going to press last week, we have been favoured with several further messages on the subject of the campaign in the United States against the teaching of the principle of biological evolution. We are glad to be able to publish these expressions of opinion upon the attempt thus being made to restrain intellectual freedom and progressive thought. As to the trial now being held at Dayton to test the validity of the anti-evolution law of the State of Tennessee, there can be no question that leaders in all departments of intellectual activity in Great Britain regard it with amazement. It is not for us to suggest that a teacher was justified in breaking the law of a State of which he was the paid servant, but what does astonish us is that the 'citizens of the State should tolerate a law which makes references to evolution and the descent of man illegal. So far as actual teaching of these subjects in schools is concerned, most men of science would not insist upon attention being devoted to them; but when the ban extends to colleges and universities, the matter becomes of prime importance.

There can be no research for truth in Nature if natural truth, including that of the creation of the universe, the earth, and man, has to be regarded as revealed, once for all, in the Biblical record. It would be impossible for any teacher of science to be true to his intelligence and yet give instruction under such conditions. There is, fortunately, no probability of limitations of the kind advocated by Mr. W. J. Bryan and the Fundamentalists being placed upon biological teaching in Great Britain; and for the sake of human progress, we trust that the reactionary movement which they represent will fail of its object. The attack has come from the advocates of traditional doctrine and not from workers in scientific fields, who ask only to be free to extend natural knowledge by research and instruction, without being bound by the words of any master. No one supposes that the problem of organic evolution has been solved, but of the fact of evolution there is not the slightest doubt, and only by further inquiry can we understand fully its course and significance. Whatever Mr. Bryan and his followers may

insist upon as regards belief, science declines to accept finality in the position of natural knowledge at any epoch, or to construct a standard which all discoverers must follow. As Huxley said, when unveiling Darwin's statue in the Natural History Museum, South Kensington, in 1885, science "commits suicide when it adopts a creed."

We need scarcely say that it is not our wish to have a discussion in *NATURE* upon Genesis and modern science, or religious belief and scientific evidence. Our sole object in taking up the subject of the prohibition of the teaching of evolution in certain States of the United States, and in inviting opinions upon this action from a number of leading authorities, has been to afford support to our colleagues fighting for scientific truth and progress against dogma and stagnation. We trust that the additional messages subjoined will give them the strength and courage they need to secure for them the position of intellectual freedom established in Great Britain many years ago, and existing unchallenged to-day.

Prof. J. GEORGE ADAMI, M.D., F.R.S.,

Vice-Chancellor of the University of Liverpool.

NOTWITHSTANDING "Main Street," it is difficult for us in the old country to realise the state of public opinion throughout the greater part of the United States outside the larger cities: difficult to realise how the minister (be he Methodist or Baptist, Congregationalist or Lutheran) and the Sunday School dominate the community. In the small country town—and every village aspires to be a town—there is no society, and no public opinion, save that centring round one or other church. He is out of society who is not a church member, and it is a commonplace for "Aunt Susan," a representative of one of the oldest families in the town, to conduct the Sunday School class, she being close upon seventy, and her class consisting of the elderly farmers of the locality and their wives and associated elderly spinsters, who have, as it were, grown up under her wing. Visit the farms and other houses of the town and you will find no solid literature that is not theological of an approved type, and of that but some three or four books. Read the local papers and you will see in them little beyond local news, of church teas and picnics, of auctions, of local weddings and funerals in most intimate detail, with a long column of notes upon the doings of local personages, how this one has left for New York or that one returned from Chicago, with, of course, full information regarding local and league doings in baseball. They contain absolutely no news about the outer world, no discussion of topics outside the range of the Sunday School. Save personal gossip and local happenings, all other topics are taboo.

The "Aunt Susans" and their elderly classes in their turn dominate the minister. For his peace of mind—and bread and butter—he dare not venture beyond the bounds of the teaching delivered over long years by Aunt Susan. All the leaders of the community would be scandalised and up in arms. They pay him, and he has no security of tenure. As a consequence an intellectual stagnation and aridity, a narrowness of outlook and a supreme confidence that opinion in Pumpkin Corner is the only possible and only right

opinion, unbelievable as they are to us, are actualities throughout Tennessee and agricultural North America.

It is this that makes possible and that explains the proceedings which have led to the Dayton trial. It is this state of affairs that explains the lack of theological progress which in itself is adequate to explain the situation in Tennessee, Oklahoma, Florida, and many other States.

It is eminently likely that in the trial at Dayton the arguments for and against evolution will not be reached. There is a matter yet more fundamental, politically speaking, than that upheld by the Fundamentalists, namely, the constitutional right to fetter liberty of thought. It is a question of supreme moment whether in the "Land of Freedom" the Tennessee decision does not contravene the Declaration of Independence and the basal right of every citizen of the United States to a reasonable liberty.

Prof. C. LLOYD MORGAN, D.Sc., F.R.S.,

Emeritus Professor of Psychology, University of Bristol.

THROUGH the courtesy of the Editor of *NATURE* I am permitted to enrol my name among those who wish to express their sympathy with advocates of the free and untrammelled spread of evolutionary teaching throughout the length and breadth of the United States of America.

I am one of those who believe that all advance in the order of Nature of which we ourselves, body and mind, are constituent parts exemplifies evolutionary progress. This may be true or it may be false. If it be true, no legislative authority can suppress it; if it be false, it will not be through legislative authority that its falsity will be demonstrated.

But I am also one of those who believe that there are thousands in America and elsewhere who find in evolution a stay and support of their deepest religious convictions. If this be so—if, as I think, it be plain matter of history vouched for by these thousands of religious people—the position, as I see it, is this: by excluding evolutionary teaching in the schools and colleges of this or that State, an avenue to the full and free development of religious faith and observance is arbitrarily barred by legislative enactment.

Unless those who attend these schools and colleges differ markedly from those young folk with whom I have been for many years acquainted in England, there will always be a certain percentage who will find that the form of theological doctrine, whatever it may be, that is prescribed under authority is such as they cannot honestly accept. In my experience a large proportion of these honest and perplexed young people scarcely know what evolution means. When they have learnt what light it may throw on the problems that perplex them, they rejoice in their new sense of freedom from the bondage that has been enforced by authority.

The Right Rev. H. HENSLEY HENSON,

Lord Bishop of Durham.

It is difficult for an educated Englishman, and *a fortiori* an educated English clergyman, to regard the proceedings in Tennessee without astonishment and contempt. The scientific theory of evolution, popularly associated with the name of Charles Darwin, has

established itself so firmly in the acceptance of all serious students in Great Britain as to be rather an axiom of thinking than a specific doctrine. Of course the concept of development is far older than Darwin. Theologians and historians discovered very quickly that the biologists were proclaiming a truth which, in other connexions, they had necessarily recognised; and the conflict between religion and science which in the middle of the last century agitated Great Britain has, so far as the issue of evolution is concerned, completely died away. Literalist theories of Biblical interpretation and irrational beliefs as to ecclesiastical authority do from time to time occasion friction between religious people and men of science, but such theories and beliefs are evidently losing their hold on the minds of thoughtful Christians, and now move more annoyance than reverence in the general mind.

Freedom of thought is the condition of sincere religion. Freedom of research and teaching is the first principle of academic life. It is incredible that such freedom should be prohibited in American universities. The accounts of Fundamentalism which come to us across the Atlantic indicate nothing more respectable than the injustice and absurdity of religious panic, such as was familiar enough in England at the time of the controversies occasioned by "Essays and Reviews." Mr. Bryan's pronouncements belong to the pre-scientific age, both in temper and substance. They are not creditable to the United States, and will be remembered as the vehement protests of a bigotry which is equally self-confident and obsolescent. They can have no permanent effect on American thought and life.

Rev. R. J. CAMPBELL, D.D.,
Holy Trinity Church, Brighton.

THAT a ban should be placed upon the teaching of evolution in publicly supported educational institutions in the United States or elsewhere is a puzzling fact. Probably it is in some degree the outcome of what is called the "Fundamentalist" controversy in religious circles in America, a controversy which has had few repercussions over here and is not likely to have many in the future. That such crises should be possible is evidence of what competent observers have long known, that American mentality, taken on the whole, differs considerably from that of Great Britain. I do not mean that it is necessarily inferior; in fact we know it is not; in some ways it is fresher, more alert, more productive, and there are certain fields of research and enterprise in which the American intellect leads the world.

Nor need we assume that the attitude taken by the authorities who exclude the teaching of evolution from the educational curriculum is wholly obscurantist. It is not. There is no country in the world wherein a generous idealism is more earnestly cherished than in the United States, nor, appearances notwithstanding, one wherein a soul-deadening materialism meets with more energetic protest. Probably, therefore, it is less the teaching of evolution than its supposed materialistic implications that an influential section of public opinion disapproves of; and this is not a bad sign.

All the same, it is an impossible position to take up. Neither religion nor morals can be safeguarded by

proscribing free inquiry in any department of human interest. It is sure to defeat itself and to produce the opposite of what is intended. There can only be one issue to the present conflict of opinion. The assured results of modern science must and will become accessible to civilised mankind everywhere.

Prof. J. W. GREGORY, D.Sc., F.R.S.,
Professor of Geology, University of Glasgow.

THE struggle in the United States over the teaching of evolution is the newest form of the age-long contest for freedom of scientific opinion. It is a warning of the dangers of elementary education becoming a State monopoly. Whether the American Constitution can be interpreted to declare the proscription of Darwinism in State schools illegal seems to be doubtful. The only relative clause appears to be an addition to the first Article of the Constitution; that addition enacted that there should be "no establishment of religion or prohibition of the free exercise thereof" and there should be no "abridging the freedom of speech." Freedom of speech in the schools is as important in the intellectual development of a nation as is the freedom of public discussion of political issues.

Evolution is now essential to the understanding of science and of natural and moral philosophy, and the prohibition of its teaching in the schools would be as fatal to sound education as would be the prohibition of the multiplication table and the axioms of geometry to the study of mathematics. In any State wherever education is compulsory, interference in teaching is a most serious abridgment of freedom of speech. Such a State has no moral right to compel its public school teachers to teach what they regard as error or to adopt a system which renders satisfactory education impossible. Hence the Article in the Constitution that guarantees the United States "no abridging of freedom of speech" may justly be applied to public school teaching and to the prevention of exclusion from the schools of the essential foundations of education.

Rev. J. O. F. MURRAY, D.D.,
Master of Selwyn College, Cambridge.

THE object of those who are promoting the prosecution of Mr. J. T. Scopes is to safeguard faith in the divine inspiration of holy scripture. Sympathising with their object, I would plead with them most earnestly to consider whether the right way to attain it is to prohibit the teaching of any conclusions that seem at first sight inconsistent with it.

If we believe that "by the word of the Lord were the heavens made," must we not believe that patient study of the stars will help us to think God's thoughts after Him? Ought we not to listen to what He is saying to us through the works of His hands? May we not hope to attain thereby to a clearer understanding of what He is saying to us through the written word? Dare we forbid any astronomer to make any suggestion as to the constitution of the universe unless he can make it fit with what we regard as the plain meaning of particular texts of holy scripture? In so doing is it really the infallibility of holy scripture that we are trying to maintain or the infallibility of our interpretation?

The method has, no doubt, been tried. The Roman Inquisition tried it with Galileo. Is that an encouraging precedent?

R. R. MARETT, D.Sc.,

Fellow, Tutor, and Dean of Exeter College, Oxford.

I AM sure that, without help from me, the citizens of the United States are quite capable of suppressing their own obscurantists. There is not the country to go back on the principle of the freedom of thought. Hence I would excuse myself from testifying to the doctrine of organic evolution, and incidentally from having to consider which particular version of it I am prepared to support at the present moment. Rather

I would remind my scientific brethren over the water, lest they take the matter too seriously, and hold themselves to be shamed in the face of the world, that there are plenty of worthy folk over here just as narrow in their outlook. I have myself been invited to lecture on anthropology to a denominational congress—held, I am glad to say, not in the British Isles but in a neighbouring country—on condition that nothing should be said about evolution. For the rest, I have had to do at Oxford with Rhodes scholars coming from the obscurantist States, and have found them apparently as well educated as the rest; whence it is perhaps to be inferred that the rising generation will not limit the circuit of their musings to suit the antiquated prejudices of their elders.

Obituary.

PROF. B. GRASSI.

THE death of Prof. B. Grassi, at Rome, on May 4, robs zoology of an ardent devotee and Italy of her most famous zoologist.

Giovanni Battista Grassi was born at Rovellasca (Province of Como, in Northern Italy) on March 27, 1854. He received his early education at a private school, and then entered the University of Pavia as a medical student. But after qualifying in medicine he threw himself whole-heartedly, for the rest of his seventy-one years of life, into the study of zoology—a subject for which he had evinced, even at an early age, a singular aptitude. (He always called himself—and posterity will endorse his definition—*zoologo*, and not *medico*.) He studied first at Messina (with Kleinenberg) and afterwards in Germany—at Heidelberg (with Bütschli and Gegenbaur) and at Würzburg (with Semper). In 1883 he was appointed professor of zoology in the University of Catania (Sicily), where he remained until 1895, when he was promoted to the chair of comparative anatomy in the University of Rome. In 1897 he was elected a national fellow of the Royal Society of Italy (R. Accademia dei Lincei), and in 1908 he was made a Senator of the Realm: until the day of his death he was—scientifically—one of the most productive members of the University, the Academy, and the Senate. Our own Royal Society bestowed the Darwin Medal upon him in 1896, but never elected him a foreign member.

Grassi's contributions to zoology are so many, so varied, and so great, that they cannot be adequately reviewed in a few words. He began his researches while still a student, and continued them unremittingly until the end of his life—despite his multifarious cares of office. (He could boast, but a year ago, that he had always given more lectures every year than the University required, and had never once missed a sitting of the Senate.) Though a man of apparently feeble physique, and handicapped from childhood by defective eyesight, he was possessed of immense energy and ardour: and he never spared himself. He used to say that mankind is composed of those who work, those who pretend to work, and those who do neither; and there can be no doubt that he himself belonged to the first class. An accomplished field naturalist, with expert morphological and systematic knowledge

of many groups of animals, he was also an accurate and original observer and an indefatigable experimenter—and one, moreover, who was always master of the literature of his subject. Consequently, his best works already rank among the zoological classics.

Many of Grassi's outstanding researches were done in collaboration with pupils and colleagues, among whom may be particularly mentioned Bastianelli, Bignami, Calandruccio, Feletti, Anna Foà, Noè, Rovelli, Sandias, and Topi. Since many of the problems which he successfully attacked—either alone or with the help of others—are not only of great zoological, but also of great medical and economic importance, and therefore bound up with various vested interests, it is scarcely surprising that his own restless research and unquenchable thirst for knowledge sometimes brought him into sharp conflict with opponents and rivals, and occasionally even with his fellow-workers: and unhappily the controversies aroused by some of his investigations have gained wide publicity, and have even tended—in certain quarters—to obscure the indisputably great merits of these investigations themselves. He recently remarked, publicly, that he "would have led a tranquil life if he had not engaged in the study of malaria and other burning questions which have a practical application." This is pathetically true, though one may be permitted to question it.

Of Grassi's works there is space to mention only some of the greatest. His earliest studies of the life-histories of intestinal worms and protozoa—begun in 1876 and continued for some dozen years—are familiar to all specialists, and contain many important observations and discoveries. He gave, for example, the first accurate account of *Giardia* (Lamblia), and was the first to ascertain (partly by experiment upon himself) the method by which *Entamoeba coli* and *Ascaris lumbricoides* are transmitted from man to man; and he was also the first to show that the cestode *Hymenolepis* completes its development without passing through an intermediate host. Curiously enough, it is only within recent years that these and others of his early observations have been verified and finally accepted.

In 1883 Grassi published his classical Naples Monograph on the Chaetognatha, a peculiar group of marine animals: and ten years later (1893) he published (with

Sandias) his famous observations on "The Constitution and Development of the Society of Termites"—one of the finest entomological-works ever written. In the course of this work he was led to make a detailed study of the peculiar protozoa with which many termites are infested; and these studies—begun in 1885, and ending with his extensive and beautifully illustrated memoir of 1917—are scarcely less important than those which he has published on the termites themselves.

In 1887 he began (with Calandruccio) a very different investigation which ultimately yielded results no less remarkable—his study of the life-history of the eels. The development of the eel is a problem which had puzzled biologists from the time of Aristotle; but in 1896 Grassi was able to announce that he had solved it, in its general terms, though full details of his work were not made known until 1913, when his magnificent monograph on "The Metamorphosis of the Murænoïds" appeared.

From about 1890 until 1892 Grassi was also occupied (with Feletti) in studying the malarial parasites. In 1898 he returned to this subject with renewed energy, and succeeded in 1898 and 1899—with the collaboration of Bignami and Bastianelli—in solving once for all the problem of the mode of transmission of human malaria. He was then able to demonstrate that certain mosquitoes (*Anopheles*), and these mosquitoes only, convey malaria from man to man; and he worked out, for the first time, the entire life-history of the human malarial parasites in these insects. The importance of these discoveries needs neither emphasis nor advertisement. His great monograph—"Studies of a Zoologist on Malaria"—was published in 1900. It is still unsurpassed, and is universally acknowledged by protozoologists as one of the classics of their science.

About 1905 Grassi turned his attention to another organism of vast economic importance—Phylloxera, an insect which has done incalculable damage to the vineyards of Europe since its accidental introduction from America some sixty years ago. With various collaborators (Foà, Topi, and others) he continued to labour

at the biology and control of this insect until the end of his life. His most important publication on the subject—issued by the Italian Ministry of Agriculture in 1912—has recently been described by a distinguished entomologist as "a milestone in the history of entomology."

Another important entomological work by Grassi is his memoir on the sand-fly (*Phlebotomus*). In this he gave (1907) the first good account of the structure and life-history of an insect which has recently attracted much medical notice, owing to the part which it appears to play in the dissemination of more than one human disease. During the last few years of his life Grassi returned again to the study of malaria and its prevention, and published—among other works—a series of most interesting papers on the biology of mosquitoes.

These are some of the works for which the name of Battista Grassi will ever remain famous in zoology—both pure and applied—and in medicine. Severally his contributions to helminthology, to entomology, to protozoology, or to ichthyology, would be sufficient to establish the reputation of a lesser man in any one of these sciences: taken together, as the work of a single individual and his assistants, they constitute a record of achievement almost unparalleled in the history of zoology.

CLIFFORD DOBELL.

WE regret to announce the following deaths:

Commendatore Giacomo Boni, director of the excavations in the Forum, Rome, and on the Palatine, where he made important archaeological discoveries in the Temple of Vesta and on the site of Domitian's Palace, respectively, on July 7, aged sixty-six years.

Dr. Charles Forbes Harford, a founder and the first Principal of Livingstone College, Leyton, on July 4, aged sixty years.

Dr. Felix Klein, For. Mem. R.S. and Copley medallist of the Society, professor of mathematics in the University of Göttingen, who has added to our knowledge of non-Euclidean and carried out researches in the theory of functions, on June 22, aged seventy-six years.

Current Topics and Events.

IN 1915 a new chapter was opened up in the cancer mystery by the discovery of Yamagiwa and Ichikawa that cancer can be successfully induced in rabbits by the prolonged application of gas works' tar. This result was soon confirmed, and during the last ten years a large number of tumours have been produced in mice, rabbits, and even in fowls. In addition to cancer in the strict sense, other malignant tumours have developed as a result of the application of tar products. There is no longer any doubt that the induced tumours are true blastomata. They possess every attribute which has been associated with the idea of malignancy. Tar is, of course, not the only chemical irritant which produces tumours, but it is the one that most readily does so under experimental conditions. It is also known that different tars vary greatly in their cancerogenic properties. The actual agent in the tar has been sought, and although not yet completely identified, a large body of knowledge has

already grown up on the subject. Apparently the acids and bases of tar can be removed while the cancerogenic agent remains.

A SHORT time ago, E. L. Kennaway, of the Cancer Hospital Research Institute, London, obtained results which pointed to the conclusion that isoprene compounds prepared at about 820° C. are more active than the original coal tar from which they are obtained. In a more recent paper (*Brit. Med. Journ.*, 1925, ii. p. 1, July 4) Kennaway has made a further important contribution to the cancerogenic properties of "tars," by showing that acetylene heated to 800°-900° C. is capable of producing tumours. A Californian petroleum, in itself apparently incapable of producing cancer, became so when heated to 800° C. in a current of hydrogen. More extraordinary still, he found that human skin or yeast dried and heated to 920° C. produced malignant tumours in mice. Although these products, up to the present, can only be produced at

high temperatures, "it is possible," as Dr. Kennaway says, "that the body at its own temperature takes months or years to produce a quantity of some substance sufficient to influence the growth of a few cells only"; whether this is so or not, it seems probable that we are getting definitely nearer the solution of the cancer problem.

YET another step in the progress of our knowledge of cancer is promised in the announcements which have appeared of a paper by Dr. W. E. Gye, to appear in the *Lancet* of July 18. At the time of writing no details are available, but it would seem that Dr. Gye, who has been supported by the Medical Research Council and assisted by Mr. J. E. Barnard and Dr. J. A. Murray, the latter of the Imperial Cancer Research Fund, has discovered a filter-passing organism in cancers of birds, rodents, and other mammals, including man. The organism itself, however, does not give rise to cancer when injected into healthy animals; it requires the presence of a so-called specific factor obtained by injecting a tumour extract from the species of animal which is being used for experiment. In the presence of extract of a sarcomatous tumour freed from the newly discovered organism, the organism itself, whatever its source, is able to cause sarcomatous growth in an animal of the species from which the extract has been made. Extracts of carcinomatous growths would appear to be ineffective. Mr. Barnard's work on the use of ultra-violet light and other short-wave radiation for photographing, under the microscope, objects of very minute size, is well known, and his share in the present work has apparently been concerned with photographing the organism. If the discovery is fully substantiated, it should mark an important advance in medical knowledge.

ON Monday, July 13, the King, who was accompanied by the Queen, opened the new house of the British Medical Association, Tavistock Square, London, in the presence of an assembly of medical representatives from the Dominions and Colonies, from many organisations in Great Britain, and from the continental countries of Europe, and a special delegation from the American Medical Association. Shortly before the arrival of the King and Queen, the memorial gates at the entrance of the courtyard of the building were dedicated by the Archbishop of Canterbury to the memory of the 574 members of the Association who lost their lives in the War. The King and Queen were attended by Mr. Neville Chamberlain, Minister of Health, and proceeded to the Great Hall of the new building, where the chairman of the Council of the Association, Dr. R. A. Bolam, read an address outlining the origin and aims of the British Medical Association. Throughout its existence, the Association has striven to maintain the traditions of the medical profession and to keep its members alive to the advance of the science and art of medicine. Medical men, he said, have a duty not only to their patients, but also to the community in the protection of public health. Reference was also made to the fact that there are now no less than

2250 women members of the Association. In his reply, the King remarked on the great increase in membership and usefulness of the Association since its foundation in 1832. The importance of qualifying examinations and prescribed training as a preliminary to admission to the Medical Register was emphasised, with the warning that "vigilance must always be exercised in order that your profession may keep abreast with the advance of science." In this connexion reference was made to the value of post-graduate study. Passing on to the relation of the medical practitioner to public health, the King said that the welfare of the peoples of the British Empire "depends largely upon an efficient and well-organised health administration," and referred to the medical practitioner as a "missionary and teacher of public hygiene and of personal health."

ON Thursday, July 9, the Sargent Laboratory of Plant Physiology at Bedford College for Women, London, was opened by Lord Justice Sargent. The Principal, in introducing Lord Justice Sargent, spoke of the sympathetic interest Miss Alice Sargent had shown towards Bedford College and of the important share she took in furthering the acquirement of the present unique site in Regent's Park. Upon her death Miss Sargent had bequeathed a sum of 1000*l.* for the furnishing of a library and herbarium in the Botany Department and for the erection of a physiological greenhouse. The War intervened before the latter project was carried out and post-War conditions rendered the unexpended balance inadequate for the purpose intended. Recently, however, as the result of a legacy, the Council of the College has been able to provide a sufficient additional sum to permit the erection of a small laboratory and experimental greenhouse.

IN declaring the new Sargent Laboratory of Plant Physiology open, Lord Justice Sargent acknowledged the kindly thought that had connected his sister's family name with the laboratory. He pointed out that Alice Sargent's contact with botany was artistic and literary rather than scientific, and that in his own mind he would always associate with the building the memory also of his other sister, Ethel Sargent, who took a keen interest and an active part in scientific botany. A vote of thanks was moved by the chairman of Council, Sir Wilmot Herringham, and seconded by the head of the Botany Department, Prof. W. Neilson Jones, after which the new laboratory was inspected. Among the exhibits were a collection of portraits of botanists and others after whom plant genera had been named, together with specimens of the plants concerned, demonstrations of researches carried out by various members of the Department of Botany, apparatus for the study of plant physiology, and a number of interesting plants. The Botany Department of Bedford College is fortunate in possessing a small but well-stocked botany garden, inspection of which provided an attractive item in the entertainment of those who attended the ceremony on July 9. The position of the new laboratory in close proximity to the garden ensures a supply of suitable plant material for work in plant physiology.

AN influential and representative deputation waited on Mr. L. C. M. S. Amery, Colonial Secretary, at the Colonial Office on July 7 to urge the claims of the Imperial College of Tropical Agriculture to continued Government assistance on an extended scale. It comprised several members of Parliament of both Houses, eminent men of science, and representatives of the principal organisations associated with the Dominions and Colonies in Great Britain. Lord Burnham, who introduced the deputation, read a letter from Mr. Ramsay MacDonald expressing interest in the movement and his hopes for its success. Sir Arthur Shipley then briefly reviewed the history of the College, and, referring to the financial position, pointed out that funds were urgently needed to enable the Governing Body to proceed with the erection of hostels and the provision of an estate. Thus the College might be placed in a position to provide for the requirements of the students, who would be proceeding to it under the scheme prepared by the Committee of which Lord Milner has been chairman, for the training of officers for the Agricultural Departments throughout the Empire. The cost of the hostel he placed at 25,000*l.* and that of the estate for research work and the practical study of farming in all its branches at 25,000*l.* Mr. Amery in reply stated that the case of the College has already been before the Committee of Civil Research, and that he hopes now to take the matter up more definitely and directly with the Chancellor of the Exchequer with the view of seeing what financial support is possible. He has, he said, the greatest faith in the future of the College, which he believes will develop into an Imperial University of Tropical Agriculture.

A MEMORANDUM regarding the probable amount of monsoon rainfall in 1925 was issued early in June by Mr. J. H. Field, Director-General of Observatories of the Meteorological Department to the Government of India. The rainfall of India is affected by previous weather conditions over various parts of the earth. For the Peninsula the indications from Java, the Cape, South America and Dutch Harbour are slightly unfavourable this year, but their combined effect on monsoon prospects is small. For north-west India a prejudicial influence exists this year from the very large excess of rainfall in south Rhodesia, and this receives some little support from conditions at Dutch Harbour; the effect of the other factors is negligible. For the Bay monsoon current the only indications as yet discovered are those from the wind and rainfall of Seychelles; the rain has been normal, but the strength of the wind is a favourable feature. Monsoon rainfall would appear to be likely to be normal or in defect in the Peninsula, normal or in excess in north-east India, and in defect in north-west India.

SIR RICHARD REDMAYNE, formerly chairman of the Imperial Mineral Resources Bureau, which has recently been amalgamated with the Imperial Institute, South Kensington, has been appointed director of the Imperial Institute. He has accepted the appointment on the understanding that it will be for a short period only, in order that he may supervise the amalgamation of the two bodies.

At the ordinary meeting of the Royal Society of Edinburgh held on July 6, the Makdougall Brisbane Prize for the period 1922-1924 was presented by the president to Prof. H. Stanley Allen, professor of natural philosophy in the University of St. Andrews, for his investigations in theoretical physics, particularly for his communication to this Society on the magnetic character of the quantum, and on static molecular models of hydrogen and helium.

THE Chalmers Memorial Gold Medal was presented at the recent annual general meeting of the Royal Society of Tropical Medicine to Prof. Warrington Yorke, professor of parasitology in the University of Liverpool and Liverpool School of Tropical Medicine, in recognition of his work on trypanosomiasis, malaria, and other subjects. The medal is awarded biennially to persons less than forty-five years of age for "researches of outstanding merit contributing to our knowledge of tropical medicine and hygiene."

M. A. F. DINA and his wife have given the Paris Academy of Sciences a sum of a million francs, the income from which is to be devoted to the manufacture or purchase of astronomical instruments for observatories concerned with astronomy, meteorology, or geophysics, together with an astronomical library for such observatories.

PROF. W. M. DAVIS, emeritus professor of geology at Harvard University, and Dr. G. Holm, Geological Survey of Sweden, Stockholm, have been elected foreign members of the Geological Society. Prof. P. Lemoine, professor of geology in the National Museum of Natural History, Paris; Dr. V. Madsen, of the Royal Library, Copenhagen; Prof. P. Niggli, professor of mineralogy and petrography in the University of Zürich; Prof. J. F. Pompeckj, professor of geology in the University of Berlin; Dr. T. W. Vaughan, of the United States Geological Survey; and Dr. M. D. Zalesky, Leningrad, have been elected foreign correspondents.

THE Summer Meeting of the Royal Cornwall Polytechnic Society will be held on July 21-24 at the Polytechnic Hall, Falmouth. An exhibition of Cornwall art and handicraft will be opened on July 21 by the president, the Right Hon. Viscount Falmouth, who will give an address on "Recent Developments of Physical Science," which will be followed by a paper by Mr. Henry Jenner on "The Holy Wells of Cornwall." Other papers to be read during the meeting are: "Boulton and Watt in Cornwall," A. K. Hamilton-Jenkin, and "The Mining Coinage of Cornwall," E. W. Newton. On Friday, July 24, a lecture will be given by Dr. W. D. Prendergast on Cornwall and the ceramic industry.

A MEDAL for archaeological research has been instituted, and attached to the Board of Archaeology in the University of London. The first presentation was made at University College, on July 7, by Prince Arthur of Connaught, to Sir Flinders Petrie in recognition of his half-century of work for archaeology. The medal bears Sir Flinders Petrie's bust on one side, and on the other the searching ibis, the hieroglyph of

"finding," placed before the head of Khufu, which was found by Sir Flinders. In returning thanks for the presentation Sir Flinders compared the expansion of the knowledge of man by the methods of archæology, to the extension of our knowledge of the universe by spectrum analysis, two movements which had grown simultaneously within his memory.

THE following are among the Civil List pensions recently granted:—Miss Maria Birch, in recognition of the services rendered by her father, the late Dr. Walter de Gray Birch, to the science of archæology, 100*l.*; Mr. J. T. Cunningham, in recognition of his services to zoological science and economic zoology, 100*l.*; Prof. Patrick Geddes, in recognition of his public and educational services, 100*l.*; Mrs. Amelia Sarah McLeod, in recognition of the services rendered by her husband, the late Prof. Herbert McLeod, F.R.S., to science, 45*l.*; Mrs. Emily Rambaut, in recognition of the services rendered by her husband, the late Dr. A. A. Rambaut, to astronomical science, 50*l.*

FOLLOWING a highly successful conference held at High Leigh, Hoddesdon, in September 1924, of those interested in special libraries and agencies for the collection, treatment and distribution of information, a representative standing committee was appointed to ensure continuity of the work. Assistance has been obtained from the Carnegie United Kingdom Trustees, and the proceedings of the first conference have just been issued. The committee has decided to name the body thus called into being "The Association of Special Libraries and Information Bureaux." The second conference of the Association will be held at Balliol College, Oxford, during the week-end September 25-28; full particulars can be obtained from the Organising Secretary at the Offices of the Association, 38 Bloomsbury Square, London, W.C.1.

Observation, of which we have recently received Part 3, is a periodical intended for readers of secondary school and training college age. It is issued by Leplay House, London, and as might, therefore, be expected, its keynote is the cultivation of the faculties of observation in everyday life. Its articles record the results of first-hand observations of peoples, activities, and places. Those in the present number deal, among other matters, with Sarawak, this by Mrs. Charles Hose, the Scillies and their bird life, London and its buildings, place names, wild flowers, and typical Norwegian farms. The articles are well illustrated.

WE have received from the Mellon Institute of Industrial Research of the University of Pittsburgh the list of publications and patents by members of the Institute during 1925. This gives evidence that the wide variety and practical utility of the subjects investigated in the Institute still continues. Laundry work, refrigeration, fire-extinction, smoke-abatement, and the design of ventilators are a few of the subjects of publications or patents. The subject "Jewelry from Fish Scales" recalls the famous experiment for extracting sunshine from cucumbers, to which the discovery of vitamins has given a new meaning. It

is evident from the list that industrial research as understood at the Mellon Institute embraces all the experimental sciences.

THE April issue of the Journal of the Franklin Institute contains two interesting papers, one, by Prof. Haber, on the practical results of the theoretical development of chemistry, and the other, by Prof. Donnan, on the influence of J. Willard Gibbs on the science of physical chemistry. Dr. Haber commences with a consideration of the "structural" period in chemistry, a period in which dyestuff investigation was developed. This was followed by the "thermodynamic" period. The application of thermodynamics to solution phenomena and the advent of the electrolytic dissociation theory fall within this period. In this connexion, nitrogen fixation and the use of catalysts in general are discussed. The third period is that through which we are now passing, namely, one in which atomic structure is being interpreted electrically. Capillary chemistry falls in this class, and the theories of adsorption are described in detail, simple explanations being given for Szyszkowski's empirical law and for Freundlich's adsorption isotherm. Prof. Donnan's lecture shows how firmly Gibbs laid down the foundations of thermodynamics, and an excellent account of Gibbs's method is given. The phase rule is given prominence, and Prof. Donnan shows throughout how much indebted are modern workers in this field to the fundamental researches of the great American physicist.

WE have received from Messrs. Adam Hilger, Ltd., a pamphlet entitled "Applications of X-Ray Spectrography and Crystallography to Metallurgy and to Chemical Problems," supplementary to the small volume on optical methods in research issued by the same firm. The pamphlet contains useful hints on the methods and limitations of X-ray spectroscopy, followed by suggestions as to the use of this method for the solution of practical problems in metallurgy. In illustration, examples are quoted from recent authors, showing how the deformation of crystalline aggregates as well as of single crystals produces characteristic changes in the X-ray pattern given by a metal, as in the work of Taylor and Elam, Polanyi, Barn, and others. An excellent bibliography is appended, from which, however, we miss any reference to the work published in *Stahl und Eisen* or in the *Mitteilungen der Institut für Eisenforschung*. Work of this kind has, among other things, shown the remarkable similarity between the structure of natural fibres, such as cotton and silk, and that of cold-drawn metallic wires. The mechanism of deformation of crystals is still a matter for controversy, and it seems probable that some refinement of X-ray technique will be necessary before this method can be expected to give results quite free from ambiguity. The evidence already available is, however, of the highest interest, and no metallurgist who is interested in the problem can afford to disregard it.

A SHORT but useful catalogue of second-hand science books has reached us from Messrs W. and G. Foyle,

Ltd., 121 Charing Cross Road, W.C.2. It gives particulars of nearly four hundred works dealing with zoology in general, with separate sections relating to ornithology, entomology, and botany. The list is sent free upon request.

MESSRS. Dulau and Co., Ltd., 34 Margaret Street, W.1, have recently issued two useful catalogues (Nos. 129 and 130). No. 129 contains some 1300 books and papers on entomology, conveniently classified under the names of the insect orders, economic and general entomology, serial publications, and Arachnida. In No. 130 are listed upwards of 2000 works classified under the headings of ornithology, mammals and sport, reptilia, fish and fishing industries, conchology, general zoology, biology, Darwinism, evolution, heredity and Mendelism. The catalogues can be obtained free upon application to the publishers.

WE have received the annual booklet, issued by Messrs. Burroughs Wellcome and Co., which gives instructions and formulæ for photographing with the aid of their tabloids and Photographic Exposure Calculator. It includes the technique of desensitising, and a page of plate speeds which brings the speed tables in the Exposure Calculator up-to-date. The booklet, "Photographic Signposts," is sent post free on application to Messrs. Burroughs Wellcome and Co., Snow Hill Buildings, London, E.C.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: A full-time teacher for mining courses under the County Council

of the West Riding of Yorkshire—The Technical Branch, County Hall, Wakefield (July 23). An assistant master to organise biological teaching in Campbell College, Belfast—The Headmaster (July 25). An assistant lecturer in mathematics in the University of Manchester—The Internal Registrar (July 31). A junior demonstrator of anatomy in the University of Birmingham—The Secretary (July 27). An assistant lecturer in engineering in the University of Manchester—The Internal Registrar (August 1). A demonstrator in physics in the University of Leeds—The Registrar (August 6). Lecturer in physiology in the University of Birmingham—The Secretary (August 24). The Dutton Memorial professorship of entomology in the University of Liverpool—The Registrar (October 1). The Ormond professorship of music in the University of Melbourne; the senior lectureship in philosophy in the University of Melbourne—The Agent-General for Victoria, Australia, Melbourne Place, Strand, W.C.2 (October 15). A full-time lecturer in mathematics at University College, Southampton—The Registrar. Lecturer on tropical hygiene at the London School of Hygiene and Tropical Medicine—The Secretary, 23 Endsleigh Gardens, N.W.1. A demonstrator in physics in the University of Toronto—Prof. J. C. McLennan, Athenæum Club, Pall Mall, S.W.1. Senior physics master at the Cowley Boys' School, St. Helens—Secretary for Education, Education Office, St. Helens.

✉ ERRATUM.—In the issue of July 4, p. 22, col. 2, line 22, for "South American" read "South Italian."

Our Astronomical Column.

THE DELPORTE OBJECT.—M. Delporte has issued a notice of erratum in his telegram announcing the finding of this object. The figures $+1^m 48^s$, N. $14'$ were really the motions in R.A. and Decl. in 2 days, not 1 day. Making this alteration, it was soon found that the object is not new, but is identical with the minor planet 29 Amphitrite, which is in opposition next October, some six months before its perihelion. It had already been perceived that Amphitrite was close to the position given by M. Delporte, but the original statement of its motion seemed fatal to identity.

Amphitrite is one of the brighter members of the family, and was discovered by Mr. A. Marth in London in 1854.

THE NEAR APPROACH OF EROS IN 1931.—Dr. G. Witt, who discovered Eros in 1898, has been studying its perturbations for many years, and gives in *Astr. Nach.*, 5375, an ephemeris from October 1, 1930 (parallax $12.2''$), to May 5, 1931 (parallax $16.4''$). It is nearest to the earth (parallax $50.3''$) on January 30, fifteen days after perihelion. Its magnitude will then be 7.1, so that it will be easily visible in a field-glass.

The declination is $+44^\circ$ on October 1, -3° on January 30, -22° on May 5.

The same issue of the *Astr. Nach.* contains a list of stars for comparison with Eros. Very few of them are fainter than 9.0 mag., so observations with meridian instruments are desired. Each plate of $2^\circ \times 2^\circ$ will contain about eight of these stars. Fainter

stars will be necessary for instruments with long focus, but their places can be photographically determined, using the stars of this list as a basis. The present list contains 419 stars and follows the place of Eros for October 1 to January 8. A second list will be issued for the remainder of the apparition.

CARBON BANDS IN COMET TAILS.—M. F. Baldet has studied the effect of pressure on the band spectrum of carbon in a thermoelectronic tube (*C.R. Acad. Sci.*, Paris, April 20). He finds that at low pressures the second and third positive groups of bands and the new group recently discovered by him disappear, leaving only the third negative group, or comet tail spectrum, and the first negative (ultra-violet) group, which remain well developed. Under these conditions the emission of light is due to electronic shocks, while at higher pressures the shocks of ionised molecules with one another and with neutral atoms are concerned, giving the other band systems mentioned above. This seems to confirm Deslandres' theory of corpuscular or electronic radiation from the sun, which produces the coronal streamers and the polar aurora. So far only the negative group of nitrogen in the comet Morehouse has been ascribed to the action of this electronic radiation; but from the work of M. Baldet and others it now appears probable that the carbon bands observed in comet tails are due to the electronic bombardment of oxides of carbon at exceedingly low pressure.

Research Items.

ARCHAIC SCULPTURE, GORGONA ISLAND, SOUTH AMERICA.—Mr. James Hornell, who is the official ethnologist of the *St. George Expedition*, organised by the Scientific Expeditionary Research Association, gives in *Man* for June a detailed account of the archaic sculptures which were discovered on Gorgona Island, off the coast of Colombia. These sculptures were on two groups of boulders, the majority of the older examples being below present tidal level. On many of the stones it can only be discerned that designs have existed, but on four they are comparatively well preserved. These form an ordered group around a huge, roughly quadrangular boulder bearing upon its upper surface the representations of a pair of rude ungainly human figures, male and female, each with a number of rays around the head in the shape of a halo. The figures stand side by side. The male measures 1 ft 10 in in height. The outlines are formed by broad, shallow, rounded grooves. On another stone is a rudely sculptured stepped pyramid of four superimposed platforms, progressively decreasing in size. Six circular depressions or cups occupy the face of the third storey and the upper half of the second. This pyramid may be a representation of an early form of the Mayan and Aztec temple of the sun, the six cups representing astral deities. Of the other two boulders, each has a representation of a monkey of crude and childish design. Other sculptures, belonging to another and later group, and pottery and stone implements were also found.

AUSTRALIAN AND MELANESIAN AFFINITIES IN SOUTH AMERICA.—Dr. Paul Rivet, in a communication to the Académie des Sciences et Belles Lettres, which appears in the *Comptes rendus* covering the session 1924, discusses the evidence for concluding that certain of the peoples of Central and South America exhibit affinities to the Australians and Melanesians. Up to the present, all efforts to establish a connexion between the languages of America and of the Old World have failed except in the case of the Eskimo, whose language probably belongs to the Ural-Altaic group. Now, however, it appears that the Hoka group, comprising a great number of tribes, extending with some interruptions along the Pacific coast from the south of Oregon to Tehuantepec, shows marked similarities in vocabulary to the Melaneso-Polynesian languages. A second, known as the Tson group, which includes the Patagonians and the Ona, in like manner exhibits affinities with the Australian languages. It is remarkable that those resemblances are found among the rare words which are common to the highly differentiated Australian dialects. In each case the similarities are the more noteworthy because the Australian and Melanesian vocabularies, from which the material for comparison has been taken, contain a comparatively small number of words. In 1909, ten Kate and de Quatrefages both pointed out that a Californian people and the Lagoa Santa race presented affinities in osteological characters with the hypsisteno-cephalic race of Melanesia, and this has recently been confirmed by R. Verneau; while Graebner, Nordenskiöld and P. Schmidt have pointed to the remarkable similarities in South American and Melanesian material culture. In the case of the Australian, Verneau has pointed to the existence of a platy-brachycephalic type in Patagonia which is Australoid, and recently Lebzelter has described an Ona cranium in which this character is even more marked.

USES OF INTELLIGENCE TESTS.—The Bureau of Education, Washington, has issued a leaflet (City

School Leaflet, No. 20), dealing with the uses of intelligence tests in 215 cities. A questionnaire was sent to all superintendents of schools in cities of 10,000 or more population with the request that they should indicate the various purposes for which they are using tests in the elementary, junior, and high schools. The replies show that group intelligence tests are chiefly used in the schools for the purpose of classifying the pupils into homogeneous groups and for supplementing the teachers' estimates of pupils' ability, and to a much less degree for vocational guidance. Individual intelligence tests are chiefly used for dealing with subnormal children and for classification purposes; standardised educational tests are used for supplementing the teachers' estimates of the pupils' ability and for comparison with other school systems. Among the other purposes are: diagnosis of causes of failure, promotion, vocational guidance, establishment of classes both for subnormal and supernormal children. The three tables supply some interesting and valuable information. It is surprising to find that they are utilised for vocational guidance purposes to a relatively small extent.

"WATER SHUT-OFF" IN OILFIELDS.—Mr. F. G. Rappoport read a paper on this important subject before the Institution of Petroleum Technologists on May 5, wherein he demonstrated the necessity for close co-operation between chemist, engineer, and geologist in dealing with this problem. Little more than arbitrary methods of prevention, usually confined to a particular well, used to be adopted, with the result that though the well might temporarily benefit, it ultimately formed the means whereby water gained access to upper oil-bearing sands over a large area. Experience, however, has taught the lesson; so much so that to-day in many countries not only is there co-operation between the various operators concerned, but Government regulations also exist in order to enforce those measures essential to the control of water flow throughout the oilfields, for example, in California, Burma, Rumania, and the Dutch East Indies. From a chemical point of view the differentiation of waters associated with petroleum is a specialised analytical process which has developed greatly during the past few years; such differentiation is to some extent a means of sub-surface correlation of water sands, and hence often a key to the disposition of related oil sands. Cementation, the universal panacea for all water ills, implies chemical research on the particular cement used. The mechanical means of preventing water encroachment concern the field-engineers, who are not only responsible for the process of cementation or other method employed, but also, acting in consultation with chemist and geologist, are careful to ensure that proper and systematic casing of the well is carried out for water shut-off, as much as for lining the well, as a factor in production.

ESTONIAN OIL-SHALE INDUSTRY.—The Estonian oil-shale or "kukersite," as it is known, was first discovered by Engelhardt some 135 years ago, but its exploitation on a commercial scale only dates from 1919, after the Estonian Government had taken over the original shale mine from the Germans, following their occupation of the country in 1918. There are now two mines, one at Kohtla (open cut mining), the other at Kukruse (underground system); a third mine at Vanamoisa has lately been developed by a syndicate operating with British capital. For 1923 there was an output from the State mines of 206,000

metric tons, while 13,140 metric tons were produced in the same year by private companies. Some diamond drill boring has been carried out for the purpose of testing the extent of available resources of kokersite, and the high reserve of 3800 million tons has been estimated; to this must be added the resources of unexplored areas, which brings the estimated total up to 5000 million tons. Experimental distillation of the shale on a commercial scale, using a continuous producer-retort, has resulted in a throughput of about 8 tons in twenty-four hours, the yield of crude oil amounting to 20 per cent. of the weight of the raw shale. The ultimate composition of this oil is carbon 81.26 per cent., hydrogen 10.15 per cent., oxygen 7.26 per cent., sulphur 1.08 per cent., and nitrogen 0.25 per cent. According to Mr. P. N. Kogerman, from whose paper before the Institution of Petroleum Technologists on April 23 these facts were gathered, this oil is at present used mainly as a fuel oil, little fractionation being attempted, though steam distillation at 100° C. yields a light oil suitable for motor cars, while a heavier fraction of "motor oil" for oil-engines distils over between 280-300° C. The residue is a high quality "shale asphalt." The success of this experimental work has led to the erection of a large oil distillation plant, consisting of a battery of six retorts with a 200-ton shale capacity in twenty-four hours, capable of yielding 40 tons of oil per day.

THE CAUSES OF GLACIAL PERIODS.—Geological evidence leads to the conclusion that there has been a more or less regular series of glacial periods, alternating with warmer interglacial ones, in the history of the earth, but the theories advanced to explain their causes have been inadequate. A well-known Russian meteorologist, P. J. Brounov, has recently put forward in *Priroda*, a periodical of the Russian Academy of Sciences, 1924, No. 7-12, a theory based on astronomical and meteorological data. Formation of glaciers, according to him, depends not so much on coldness of climate as on the quantities of snow falling in a certain country. The main factor causing snowfalls are the ascending currents of air which are characteristic of cyclones. There are two zones of cyclones in the northern hemisphere—the northern, where the cyclones have a N.N.E. direction and bring snowfalls, and the southern, with warm, rain-bringing cyclones. The two zones are separated from each other along the zone of barometric maximum, which runs around the globe between latitudes 33° and 35°. The latitudinal position of this zone plays a most important part in determining the climate of the two cyclone zones. Its position, however, depends to a great extent on the velocity of rotation of the earth, since this influences deviation in the direction of cyclones. There is extensive astronomical evidence that the velocity of rotation of the earth undergoes fluctuations dependent on various causes. These fluctuations must result in corresponding shiftings of the zone of barometric maximum, that is, in considerable changes of climatic conditions in the cyclone zones. Acceleration of the velocity must result in shifting the zone of barometric maximum towards the equator, and that would mean a corresponding extension southwards of the northern zone of cold cyclones with snowfalls; on the other hand, when the rotation of the earth becomes slower, the zone of maximum is shifted northwards and warmer conditions prevail in the middle latitudes. During the last glacial period, according to Prof. Brounov, the zone of barometric maximum ran in Europe, roughly speaking, along the Mediterranean Sea; after that period it shifted northwards, which resulted in a relatively dry and warm period; at present the zone is apparently shifting

southwards, and Europe is threatened with a new glacial period.

A NEW PENTAMEROID BRACHIOPOD FROM ALASKA.—Mr. E. Kirk has published a description of Harpidium, a new pentameroid brachiopod from the Upper Silurian of south-eastern Alaska (Proc. U.S. Nat. Mus., vol. 66, art. 32). So far as at present known the genus is not represented elsewhere. It resembles Conchidium in its general proportions, and Pentamerus in being nonplicate, but Harpidium and Conchidium seem much closer genetically than either is to Pentamerus. No true Pentamerus has as yet been found in faunas of the north Pacific type, but in the interior of Alaska what appears to be a Pentamerus has been met with. The interior region of Alaska, however, has closer affinities with the Rocky Mountain geosyncline and the interior of America than it has with the true Pacific region. The more or less complete separation of Pacific and interior faunas seems to have held up to the time of the high middle Devonian, when there appears to have been fairly free communication between the two faunal regions. The author describes and figures three new species of Harpidium.

UPPER AIR IN EGYPT AND THE SUDAN.—The Ministry of Public Works, Egypt, has issued a Physical Department Paper, No. 17, on "The Upper Currents of the Atmosphere in Egypt and the Sudan," by Mr. L. J. Sutton, Director of the Meteorological Service. Pilot balloon observations were commenced at the Observatory of Helwân, 25 kilometres south of Cairo in 1907, and daily ascents have been made except on Fridays, during the four years 1920-1923. Other observations were made at Wadi Halfa, Khartoum, Mongala, and Roseires on the Blue Nile. The object of the paper is not only to find mean values of the wind velocity and direction at various heights but also, when possible, to associate these values with recognised types of pressure distribution at the surface; thus a study of the daily weather map will provide better assistance in anticipating the upper winds than can be obtained from mean values calculated without respect to the surface pressure. Eleven different types of weather in Egypt are considered, and the accompanying pressure and winds are illustrated by the several maps covering the surrounding neighbourhood for each. The frequency of occurrence for each type is given for the several months and for the year. The discussion will without doubt prove very helpful for aviation, and much valuable information is given of the upper air changes for the several stations and for the different types of weather.

A STUDENT'S THEODOLITE.—The teaching of practical surveying is often hampered by the fact that the number of instruments available for instructional purposes is small in relation to the number of students in the class. The cost of the apparatus is usually the cause of the scarcity. A Student's Theodolite, which has recently been placed on the market by Messrs. C. F. Casella and Co., Ltd., 49 Parliament Street, London, S.W.1, should help to overcome this difficulty. The tribrach, upper horizontal plates and standards are made of seasoned mahogany. The circles are of hard white celluloid, 6 inches in diameter, and engine machined to 1°. The telescope, which gives a magnification of about 4 diameters, has a fixed diaphragm, and both object-glass and eye-piece can be focussed. A graduated bubble and a trough compass are provided, and the instrument is mounted on a twofold tripod. The accuracy obtainable is not of the same order as that of a professional model, but the instrument reproduces all the essential features of a standard

transit theodolite. The outfit should prove of service not only in assisting students to obtain an acquaintance with the broad principles of survey work, but also in preparing them to use instruments with vernier or micrometer scales and other fine adjustments.

THE SPECTROSCOPIC DETECTION OF ISOTOPES.—In line spectra, due to electronic jumps in the atoms, the effect of isotopes is exceedingly minute, since the energy changes are governed by the amount of the nuclear charge, and the mass of the nucleus is of very little importance in determining the frequency of the emitted light. In a paper in the March issue of the *Physical Review*, Dr. R. S. Mulliken gives the results of an investigation of the band spectrum of boron monoxide, having shown in a previous paper that, in the case of a compound, one of the elements of which consists of two isotopes, two similar superposed band systems are to be expected, on somewhat different scales, and with intensities proportional to the relative amounts of the two isotopes in the element. The band spectra are due in part to electronic jumps, but also very largely to vibrations and rotations of the molecule, in which the masses of the nuclei are of importance, and the isotopic effects are considerable. Two such band systems exist in the spectrum of boron monoxide, the weaker and larger scale system being apparently due to the less abundant isotope, B^{10} , and the other to B^{11} . At certain positions in the spectrum, differences of more than 40 Å.U. were observed between the wave-lengths of corresponding band heads. The measurements agree in a remarkable manner with the theory.

MEAN FREE PATH OF NEUTRAL SILVER ATOMS IN NITROGEN.—Dr. F. Bielz describes, in the *Zeitschrift für Physik*, April 28, a series of measurements made with an apparatus similar to that previously employed by Prof. Born and Fraulein Borman. A stream of silver atoms passed from a chamber, which was heated in an electric oven, through a narrow tube, into a space containing cool nitrogen at a low pressure, forming a narrow "beam." Three small glass plates at different distances from the entrance tube could be shifted in turn into the path of the beam by means of a magnetic arrangement, the times of exposure of the three plates being nearly equal. The thin layers of silver deposited were treated with iodine vapour to convert them into silver iodide, and their thicknesses, which varied with the distance from the entrance tube, were measured, using an Abbe microspectroscope and the Wiener interference method. The mean free path of the silver atoms was then calculated by means of a formula derived by the author, and it was found that the product of pressure and mean free path was constant, within the limits of experimental error, for pressures of 1 to 7×10^{-3} mm. Hg. The radius of the neutral silver atom calculated from this product is 1.0 Å.U.; values ranging from 0.57 Å.U. to 1.78 Å.U. have been found by other observers using other methods. Dr. Bielz states that no source of error occurs in his experiments which would make his value too low.

OPTICAL PHENOMENA AND THE QUANTUM THEORY.—In the April number of the *Physical Review*, Dr. J. C. Slater puts forward a detailed theory of optical phenomena, based on suggestions already made by him in conjunction with Bohr and Kramers (*Phil. Mag.*, vol. 47, p. 785). The atoms are supposed to radiate and absorb during the stationary states, and the transitions from orbit to orbit influence radiation only by terminating the radiation characteristic of the first state and commencing that of the second. The strict law of conservation of energy does not hold, since the atoms do not change their energy

while radiating, though the energy in the field of radiation increases during this interval; the atomic energy changes discontinuously during the transitions. There is, however, conservation of energy and of momentum, considering both the atomic energy and that of the radiation field, when an average is taken over a great number of atomic processes. The new suggestion is made that resonance radiation is to be identified with the radiation of the spherical wavelets which, by their interference with the external field, also produce absorption. Einstein's statement of the probabilities of the transitions of atoms is used, and the probability of interruptions of coherent vibrations is discussed. Detailed descriptions of the fields emitted, which consist of spherical wavelets with the frequencies of the various quantum lines which the atom can emit or absorb in its existing stationary state, are given, and it is shown how dispersion results. The assumptions made satisfy the correspondence principle, and the radiation field is essentially like that of the classical theory, which is known to agree generally with experiment. The theory gives a minimum value for the breadth of emission and absorption lines, which is the same for both classes and depends on the finite life of the wave-trains; Kirchhoff's law also holds for these lines. The applications of the new theory to emission of light by bombardment with electrons at the resonance potential, to resonance radiation and its quenching by foreign gases, and to absorption, scattering and dispersion are dealt with in a satisfactory manner.

TOTAL HEAT OF SUPERHEATED STEAM.—The electric lighting industry is looking forward to great improvements in steam generation in the boiler-house. During recent years the standard working steam pressures have risen from 200 lb. per sq. in. to 450 lb. per sq. in.; but much higher pressures are in use. The Edison Co. of Boston has boilers supplying steam at a pressure of 1200 lb. per sq. in. to a high back pressure turbo-generator. The exhaust steam is reheated to 700° F., and then enters a second turbine which is of ordinary construction. Engineers are contemplating even higher pressures. In the June issue of *World Power*, a valuable report by Prof. H. L. Callendar to the Electrical Research Association on the total heat of superheated steam at high pressures is published. Many conflicting tables have recently been published in Germany of the total heat at saturation. As a rule these have been obtained by extrapolating empirical formulæ representing small uncertain deviations at comparatively low pressures, little regard being paid to the well-known properties of fluids in the critical region. In this report Prof. Callendar describes a direct method of measuring the total heat which has already been applied successfully at moderate pressures and, provided the difficulty of regulating the pressure can be surmounted, there is no reason why it should not give with equal facility accurate results at the highest pressures obtainable. There are many advantages in the steady flow method of calorimetry which he adopts over the more ordinary methods. The difference of temperature to be measured is steady, and admits of direct observation by a single reading with a differential pair of platinum thermometers. No correction has to be applied for the water-equivalent which is so great a source of uncertainty at high temperatures. The flow of the fluid itself supplies sufficient stirring, and each part of the apparatus can be jacketed with its own flow. A discussion is given of the effect of time-lag in evaporation of nuclear drops. The primary object which the author has in view is the verification of the tables of the total heat near saturation, and his results will be of great value to the electrical industry.

Southampton Meeting of the British Association.

LOCAL ARRANGEMENTS.

THE week from Wednesday, August 26, to Wednesday, September 2, will see the British Association for the Advancement of Science at Southampton for the third time in its long history of ninety-five years. Twice in the past, in 1846 under the presidency of Sir R. I. Murchison, and also in 1882 under Dr. (afterwards Sir) Charles Siemens, has it met there, and this year will see it once again in Britain's premier passenger port under Prof. Horace Lamb, formerly of the University of Manchester. Arrangements have been made with British railways so that members of the Association attending the meeting may obtain return tickets to Southampton at the price of single fare and a third.

The Reception Room will be the King Edward-VI. Grammar School, which is conveniently and centrally situated, facing the open space called the Marlards, on one side of which is the public stance for charabancs, while close behind it is the West Station on the main Southern Railway line from Waterloo to Weymouth, at which most of the visitors to the meeting will alight from their trains. For the convenience of the members it has been arranged, with the railway authorities for a special train to be run from Waterloo on the day before the opening of the meeting (Tuesday, August 25). Within easy distance of the Grammar School are to be found the shops and restaurants of Above Bar Street, and an agreement has been reached with a firm of local caterers to take for the week of the visit the Coliseum, a hall capable of seating 1600, and run it as a restaurant at which lunches and teas may be had.

At the town end, within a short radius—half a mile at most—of the Reception Room, sections A, B, C, F, G, and M have found suitable accommodation. In the Free Library across the park from the Grammar School, C (Geology) comes nearest; opposite it, at the far corner of Brunswick Place and Dorset Street, A (Mathematics and Physics) occupies the Lamb Memorial Hall; farther up the street from the Free Library on the London Road we find in order B (Chemistry) at the Kell Hall, corner of Bellevue Road, and M (Agriculture) at the Friends' Meeting-House in Ordnance Road, immediately opposite the main entrance to the Ordnance Survey Office. In the opposite direction from the Reception Room, at the bottom of East Street, F (Economics) and G (Engineering) are housed in the new Wesleyan Central Hall, the auditorium of which will be the place of meeting for the presidential address on the evening of Wednesday, August 26, and also for the Children's and Citizens' Evening Lectures. The Royal Pier, in the pavilion of which the mayoral reception will be held on the evening of Thursday, August 27, is at a tramcar terminus not far from the south end of the High Street, which, passing northwards as Above Bar Street, London Road, and the Avenue, is the principal thoroughfare of the town. About the middle of the Avenue, section H (Anthropology) is located at the Avenue Hall, attached to the Avenue Congregational Church. The ordinary tramcar service passes by or very close to all these meeting-places, the last mentioned of which, the Avenue Hall, is the most distant, being about one mile from the Reception Room.

The remaining sections, D, E, I, J, K, and L, meet at the University College, Highfield: D (Zoology) in the main corridor to the right of the south entrance on the ground floor next to the Women's Common Room; E (Geography) in the Engineering block—

associated with this section is the important exhibition of maps belonging to Sir George Fordham; I (Physiology) at the opposite end of the main corridor to D on the ground floor opposite the Men's Common Room; J (Psychology) in the Library and Senior Common Room on the first floor above I; K (Botany with the subsection of Forestry) on the first floor above D; and L (Education) in the newly built Assembly Hall opposite the College Refectory, where luncheons and teas may be had. This grouping of half the sections at the University College, which is rather remotely placed from the central Reception Room and is a good ten minutes' walk from the tramcar termini at either Bassett or Portswood, has necessitated for the convenience of the members a special bus service past the College buildings to join up with the rest of the town.

The University College has put its three hostels at the disposal of the Association. The largest, South Stoneham House, a Queen Anne mansion surrounded by beautiful grounds, will house the Secretariat; the next, Highfield Hall, will accommodate some sixty members as a hostel, and in the same way South Hill, a former residence of the Bishop of Southampton, about half that number. South Hill is situated some ten minutes' walk from the Bassett tramcar terminus or from the University College. Highfield Hall is on the Common, not far above the Avenue Hall; while South Stoneham, a former residence of Lord Swaythling, is at Swaythling, close to the car terminus and railway station of that name. It is fully two miles distant from the Reception Room and almost three miles from the Wesleyan Central Hall, though connected to both by electric tram service of some half an hour's duration.

Garden parties have been offered by Lord and Lady Swaythling at Townhill Park; Lord and Lady St. Cyres at Walhampton, near Lymington; and Mr. W. Collins at Westend; while the Cunard and White Star Companies, with their wonted generosity, have invited as many members as may care to go to see over one of their ships.

Southampton is remarkable for its fine open spaces, which stretch from the lower part of the town almost without break to the Southampton Common, the latter covering an area of more than 360 acres of virgin land. Its immediate environs include many places of great natural beauty. General excursions are being arranged to visit old Southampton, the Docks, New Forest, Stonehenge, and other places of interest in the neighbourhood. The full list of excursions, including sectional ones and visits to works, will be given later in detail. While tickets for the general excursions will be obtainable at a counter in the Reception Room, those for all the sectional excursions may be had from the local sectional secretaries at the various rendezvous of the sections during the week of the visit. The committee of the Royal Yacht Club has very kindly extended hospitality of honorary membership to the visiting members of the British Association.

Southampton, rich in historical associations, favoured by its geographical situation at the confluence of the rivers Itchen and Test, and unique in its modern commercial development, awaits the advent of the British Association into its midst with great interest. It is fully conscious of the honour conferred on it by such a visit, and is determined to make it the signal success which the occasion demands.

W. RAE SHERRIFFS.

Meteorology in the Republic of Colombia.

ON the occasion of the establishment of a new observatory at Bogotá, capital of Colombia, in connexion with a general reorganisation of official geophysics in the Republic, the director, the Rev. S. Sarasola, S.J., is anxious that attention be directed to the first publication of the new institution (*Notas Geofísicas y Meteorológicas*, No. 1, Bogotá, 1924). This comprises a description of the new observatory, a history of previous observatories, in the work of which Baron Humboldt interested himself a century or so ago when travelling in South America, an account of the physical geography of Colombia, and a discussion of climatic, magnetic, and seismic conditions, together with copious meteorological statistics for Bogotá, at an altitude of about 9000 ft. on the eastern ridge of the Cordillera, and other cities.

Father Sarasola desires especially to make known that neither at Bogotá nor other places in this quarter of the globe does observation establish anything in the nature of a constant upper wind from the S.W. answering to the "anti-trade" of the text-books. It appears from the data relating to upper-cloud movements which are given, not only for Colombia, but also for neighbouring countries, including the West Indies, that the most prevalent direction of the upper current is S.E. rather than S.W. Thus, we would observe, is in conformity with the view that the real direction of the return or counter-trade in the northern hemisphere, at the equatorial limit, is S.E., becoming S.W. towards higher latitudes (see, for example, W. R. Blair's paper on the planetary circulation in the *Monthly Weather Review* for April 1916). But however this may be, we are really not surprised at Father Sarasola's failure to observe a constant anti-trade over Colombia, and we think that he may possibly be under some misconception as to the extent to which European meteorologists nowadays really believe in the *fixity* of the so-called trades and anti-trades. The fact of the matter is that these terms, though useful and proper generalisations from the facts of wind and pressure distribution as shown on mean or average charts, should not be applied too rigorously to actual momentary distributions without first of all formulating a definition of what a trade or anti-trade really is. Not only do the conventional trades moving round the flanks of the subtropical anticyclones shift their latitudinal limits

with the seasons, but they also vary their position with changes in the day-to-day distribution of pressure, so that the task of identifying a given air-current as a "trade" would not always be possible without an exact definition which would be difficult to frame. We are therefore the more convinced, from the unfruitful search in Central and South America for the *stereotyped* anti-trade of the text-books, that the terms "trades" and "anti-trades," like "westerlies" of higher latitudes, should only be used in a generalised sense to denote the average trend of the circulation of the atmosphere within certain belts of latitude. At the same time we are fully aware that there are certain ocean tracts where unmistakable "trades" do blow very steadily for weeks on end in a way that the highly variable "westerlies" do not.

Since climate cannot be properly portrayed by statistics alone, which can never render local colour, it is pleasing to find Father Sarasola quoting a vivid description of a writer, Señor Caldas, of climatic conditions on the west coast of Colombia, which, with a mean annual rainfall of about 200 in., is one of the wettest regions of the globe. We render the passage from the Spanish: "It rains for the greater part of the year. Legions of clouds hurl themselves against the sky from the direction of the Pacific. The west wind, which reigns constantly over those seas, flings the vapours on to the continent where the Andes arrest them in full career. There the clouds accumulate and give the mountains a dark and menacing aspect. The sky vanishes, and on all sides appear nothing but heavy black clouds threatening all living creatures. An oppressive calm supervenes marking a terrible moment; then a hurricane of wind uproots immense trees, to the accompaniment of electrical explosions with dreadful crashes of thunder; the rivers leave their channels; the infuriated sea inundates the coast with gigantic waves; sky and earth are confused, and all seems to herald universal destruction. In the midst of so much turmoil the traveller turns pale; but the native of the Choco stays quietly at home in the bosom of his family, for long experience has taught him that the results of such convulsions of Nature are seldom mournful, that it is all nothing but light, water, and noise, and that within a few hours equilibrium and calm will be restored."

L. C. W. BONACINA.

Chlorocruorin.

THE study of the pigments occurring in Nature has shown that from both the hæmoglobin of animals and the chlorophyll of plants, substances of similar chemical constitution can be derived under the influence of appropriate reagents. These bodies are known as the porphyrins and are made up of pyrrol groups: but from this point the resemblance between hæmoglobin and chlorophyll ceases, since the former contains iron in its molecule, while magnesium is present in the latter; also the other groups present in the respective molecules and the functions of the substances themselves are different. How far the resemblance between these two pigments is significant is uncertain, since the details of the synthesis of hæmoglobin in the animal body are unknown, but it is possible that the pyrrol rings have some special property which serves as a useful basis on which to build up more complex substances with the peculiar properties of hæmoglobin and chlorophyll respectively. In this event the difference in their functions will be largely due to the other constituents of their molecules.

There appears to be no reason, however, why other substances derived also from the porphyrins should not be found in Nature, if compounds with similar, or possibly even dissimilar, properties to hæmoglobin or chlorophyll are required in the economy of the organism. An example is chlorocruorin, the green pigment in the plasma of certain polychaetes (the Chlorhæmidæ and the Sabelliformia). H. Munro Fox (Proc. Cambridge Philosophical Society (Biological Sciences), 1924, vol. 1 p. 204) has recently given an account of some of the properties of this substance. The specimen examined was obtained from the blood of *Spirographis Spellanzani*; and although green in colour it is related to hæmoglobin, in that the porphyrin from which it is derived is the same as, or closely allied to, hæmatoporphyrin. The pigment exists in both the oxidised and reduced forms, and from it a series of derivatives can be obtained which resemble those obtained from hæmoglobin. The spectra of these derivatives are in many cases very similar to those of the parallel derivatives of hæmoglobin but with the bands shifted towards

the red end of the spectrum: in a few cases the resemblance between the derivatives is less close. Even when the protein part of the molecule has been removed, leaving the hæmatin derivative, the two hæmatins are not the same, so that although each consists of porphyrin + iron, the method of combination must be different. Further divergence occurs when the protein is added to the iron-containing part of the molecule.

The chemical similarity between chlorocruorin and hæmoglobin suggests a similarity of function also. Indeed the author shows that chlorocruorin can act as a respiratory pigment, in that the oxidised form can be reduced by exposure to a vacuum or by living tissues. The amount of oxygen in the blood of *Spirographis* appears to be about one-third of that found in a similar quantity of human blood. The function, however, of this pigment in the economy of the worm is uncertain, since the blood does not undergo a complete circulation. Although it may not convey oxygen from the surrounding medium to the body tissues as hæmoglobin does, yet it may permit of a more active gas exchange and perhaps, at times, make the worm less dependent on the oxygen in the surrounding water. Chlorocruorin thus appears to be "a unique case of the parallel evolution of a substance resembling hæmoglobin."

University and Educational Intelligence.

ABERDEEN.—Applications are invited from graduates of the University of Aberdeen for the Wilson Travelling Fellowship, which is for archæological and anthropological research in the near East, including the Balkan Peninsula, Asia Minor, Palestine, Egypt, and Mesopotamia. The fellowship is of the annual value of 300*l.*, with a possible increase, and is tenable for two years. Applications must be received before August 1 by Mr. A. Martineau, 1 Golden Square, Aberdeen.

BELFAST.—At the Summer Graduation Ceremony of the Queen's University, held on Friday, July 10, Prof. F. G. Donnan of University College, London, received the degree of D.Sc. *honoris causa*. After a very distinguished career as an undergraduate of Queen's College, Belfast, Prof. Donnan obtained his degree with the highest honours in the late Royal University; and as professor of chemistry in the University of Liverpool and in University College, London, he has done work which has gained for him a foremost position amongst chemists. The degree of D.Sc. *honoris causa* was also conferred upon Prof. E. W. MacBride, professor of zoology of the Imperial College of Science and Technology, London. Prof. MacBride was a student and scholar of Queen's College, Belfast. He entered St. John's College, Cambridge, of which he became a fellow, and he also graduated with the highest honours in the University of London. His work as a zoologist at McGill University, Montreal, and the Imperial College, London, is well known.

BIRMINGHAM.—Sir Oliver Lodge has been appointed Huxley lecturer for session 1925–26, the subject of his lecture being "Difficulties of the Ether."

Dr. G. F. Still has been appointed Ingleby lecturer for 1926, and Dr. Leonard G. Parsons for 1927.

Prof. Leonard Gamgee has presented to the University a sum sufficient to provide a gold medal to be awarded annually to the candidate who passes the summer final examination for the M.B., Ch.B. degree and who gains the highest marks for surgery. The medal is to be called the Sampson Gamgee medal and is in memory of Prof. Gamgee's father, who worked for many years in the Birmingham Medical School.

Prof. T. Turner has been elected Dean of the

faculty of science in succession to Prof. F. W. Burstall, his term of office beginning on September 1.

At the recent degree congregation there were conferred, among others, the following degrees:—D.Sc., 3; Ph.D., 5; M.Sc., 11; B.Sc. with Honours, 80; B.Sc. (Ordinary), 58.

EDINBURGH.—Prof. Shield Nicholson has resigned the chair of political economy, to which he was appointed in 1880.

The University Court at its meeting on June 15 approved the terms of an ordinance for the foundation of the Abercromby chair of archæology.

The resignation of Mr. J. F. Rees, reader in economic history, was received and was accepted with regret. The University Court congratulated Mr. Rees on his appointment to the chair of commerce in the University of Birmingham, recently vacated by Sir William Ashley.

Intimation was received of a legacy by Miss Catherine S. Howden of 5000*l.* to found a scholarship for research work, preferably in the domain of nervous diseases, and of a gift of 50*l.* by Mrs. John Harrison, to be applied in assisting the printing of research papers by members of the University.

Dr. J. M. Woodburn Morison of Manchester has taken up the duties of lecturer in electrical therapeutics and radiology, which is part of a new course in clinical pathology.

LONDON.—Prof. E. A. Gardner has been re-elected Vice-Chancellor for the year 1925–26.

The title of professor of mycology in the University has been conferred on Mr. E. S. Salmon in respect of the post held by him at the South-Eastern Agricultural College. The title of reader in mycology in the University was conferred on Mr. Salmon in 1912, and since that date he has published numerous papers on fungous diseases of plants and on fungicides.

The title of emeritus professor of hygiene and public health in the University has been conferred on Sir William J. R. Simpson, as from the end of the present session, on his retirement from King's College, after twenty-seven years' service, on the closing of the Department of Bacteriology and Public Health.

ST. ANDREWS.—M. Étienne Gilson, Professor of the Philosophy of the Middle Ages at the Sorbonne, Paris, has just published a text of René Descartes' "Discours de la Méthode" with a commentary. The volume is dedicated to the University of St. Andrews, which has recently bestowed the degree of LL.D. upon M. Gilson.

We learn from *Science* that Mr. G. E. Merrick has given 160 acres of land and a sum of 5,000,000 dollars towards the establishment of a university in Miami, Florida. The university, which was granted a charter on April 5, will be non-sectarian and co-educational.

APPLICATIONS are invited by the Royal College of Physicians for the Streatfeild Research Scholarship in medicine and surgery, the annual value of which will probably be 250*l.* and the tenure three years. Applications must reach the Registrar of the College, Pall Mall East, S.W.1, not later than October 1.

THE Dickinson Travelling Research Scholarship in medicine, which is open to students of the University and Infirmary, Manchester, has been awarded by the Trustees of the Manchester Royal Infirmary to Dr. Raymond Williamson and to Mr. Leslie J. Witts.

THE London School of Hygiene and Tropical Medicine is prepared to consider from qualified medical practitioners applications for four research

studentships in tropical medicine and hygiene. The studentships are each of the value of 250*l.* yearly and will normally be for two years. The latest date for the receipt of applications, which should be sent to the Secretary of the School, 23 Endsleigh Gardens, N.W. 1, is August 31.

APPLICATIONS are invited by the council of the University College of the South-West of England, Exeter, for the Andrews Simons research studentship, value 120*l.*, for the furtherance of experimental research in physics, chemistry, or other branch of science. The applications must be received by the Registrar not later than August 1.

THE Royal Commissioners for the Exhibition of 1851 have made the following appointments to Senior Studentships and Overseas Scholarships for 1925—*Senior Studentships* Mr O. M. B. Bulman, Imperial College of Science and Technology (Geology); Mr P. A. M. Dirac, Cambridge (Mathematical physics); Mr I. R. McHaffie, University College, London (Physical chemistry); Mr H. W. B. Skinner, Cambridge (Physics); and Mr D. L. Thomson, University of Aberdeen (Bio-chemistry). *Overseas Scholarships*. Mr C. L. Huskins, Alberta (Cytology); Mr A. R. Fee, British Columbia (Biology); Mr C. S. Hanes, Toronto (Biology); Mr J. G. Wood, Adelaide (Botany); Mr V. M. Trikojus, Sydney (Organic chemistry); Mr S. W. Watson, South Africa (Physics); Mr R. S. Allan, New Zealand (Geology); and Mr J. J. Lennon, University College, Dublin (Organic chemistry).

THE Ramsay Memorial Fellowships for chemical research are administered under a scheme framed on an international basis, the participating countries being Great Britain and Ireland, Canada, Denmark, France, Greece, Italy, Japan, the Netherlands, Norway, Spain, Sweden, and Switzerland. The fellowships, sixteen in number, are tenable in any university or other place in the United Kingdom possessed of the requisite facilities for research. In a speech made in response to the toast of the trustees of the Ramsay Memorial Fellowships proposed by Sir William Bragg at a dinner given at University College, London, on July 3, Sir Robert Hadfield expressed the opinion that the bringing into our midst of young chemists selected from other countries to undertake research work has been a great success in promoting friendly relations and mutual understanding between men of science of different countries. He quoted with approval a suggestion made by a former fellowship holder, Prof. Henri Weiss of the University of Strasbourg, that the fellowships should be extended and young British skilled research workers should be sent to foreign universities. This theme—the rôle of the *savant* abroad as not only purveyor of light but as promoter of peace and goodwill—is one on which quite a number of public pronouncements have been made in Great Britain during the past six months by eminent men of science, and it was discussed at length at the annual conference of the Universities of Great Britain and Ireland on May 9. In the United States likewise it has been much discussed and large sums of money have been appropriated to translating aspirations into actualities, such as the John Simon Guggenheim Memorial Foundation, to which a "preliminary" gift of 3 million dollars has been made, to provide annually from forty to fifty fellowships for "advanced study abroad." The American Council on Education has published in the *Educational Record* for April a list of seventy-six organisations interested in such relations, and proposes to invite them all to a conference to be held at Washington in the autumn.

Early Science at Oxford.

July 21, 1685. Mr. President being in the Chair acquainted the Society that in Northamptonshire about two or three miles from Astrop, there is dug a heavy black earth, which being calcined comes to a black sand, some of which he was pleased to shew us, almost as heavy as ye earth. A Magnet being applied to this sand, was seen to attract it.

A letter of Mr. Leewenhoeck's concerning ye Generation of man &c: from an insect was read

Dr Bernard presented some papers of Mr. Greaves giving an account of some experiments made at Woolwich in ye year 1651 for ye triall of great guns—The Doctor also presented ye Society with a *Cornu Ammonis*, some *Balenmites*, *Lignum fossile*, *Ostracites*, all which were dug out of a well on a hill near Faringdon.

A Letter from Mr. Aston dated July 15 was read, it affirms ye true Zaffer is nothing but Kobalt calcined, ye comon Zaffer being adulterated with pebbles.

Dr. Plot presented a Persian wood, which was observed to sink in water; and a Hen's egge sent him from out of Yorkshire, having a round hole at one end of about half an inch diameter. This hole was exactly fitted by a little cap of ye same matter with ye rest of ye shell, but more protuberant, than ye end of an Egg-shell is naturally, and full of wrinkles; the Cap is said not to have been continued to ye main body of ye shell, but sticking close by its inner side to ye membrane, was by these meanes kept as a cover on ye hole.

A letter from Mr. Cole of Bristol, dated July 16th, was communicated by Dr. Plot and read

July 22, 1684. Two Letters from Mr. Aston, one dated July ye 10, ye other 17, were read: An Abstract of a Letter from Dr. Huntingdon says, that Mr. Tennant, a gentleman in Ireland, has lately invented an Engin for ye throwing of water, far exceeding that of Sir Samuel Moreland.

Some of ye curiosities lately presented to ye University by Mr. Cole of Bristol, were communicated to ye Society by Dr. Plot; as first, *Sal Gemmæ* from St. John de Port Rico, one of ye Leeward Islands near Jamaica. It breaks generally into squares; is transparent near four inches thick, so that at that thickness ye motion of a finger, playing up and down, may easily be discerned. Secondly, *Silk Grass* of three yards long found in ye swamps, or moorish grounds, in Virginia, growing upon a tall plant from which it is strip't like Hemp. Thirdly *Neopolitan black writing sand*, which applied to ye Magnet in great quantitys, and much more readily than ye *ferrum Noricum*, or any other ore we have yet seen. Some of this sand being calcined by Dr. Plot, ran into a mass, which, when cold, was very brittle. Other experiments will be tried on this sand by ye Doctor, of which we are promised an account

Mr. Cunningham affirms, that *Sal Gemmæ* is commonly thrown up by ye Lammas floods within six miles of St. Andrews, and used by ye poor people instead of common salt.

A letter from Mr. Flamsteed to Mr. Caswell, concerning ye late eclipse of ye Sun, and ye *Macula Solis* observed by him, was read. This great Astronomer does, in this letter, seem to question, whither these spots, seen by him, were not two differing spots, rather than revolutions of ye same spot, altho ye manner of their course along ye disc of ye Sun, seems to be much alike, and therefore argues ye latter

Societies and Academies.

LONDON.

Royal Meteorological Society, May 20.—F. W. Harmer and C. E. P. Brooks: Further remarks on the meteorological conditions of the Pleistocene epoch. The chief difference between the North Atlantic and North Pacific Oceans is that the former is open to the north, while the latter is practically closed to the north. Hence in the Atlantic the Gulf Stream travels north-eastward into the Arctic Ocean, while in the Pacific the Japan current is forced to turn south-eastward along the coast of America. This difference causes differences in the pressure distribution; both oceanic and atmospheric circulation combine to give western Europe a more genial climate than the west of North America. The closing of the Greenland-Europe channel would bring about changes in the oceanic and atmospheric circulations which would suffice to cause a glacial epoch in Europe. The diversion of the storm tracks and the consequent alteration in the direction of the prevalent winds are probably even more important than the changes in the currents. The second part of the paper deals with the climatic changes in the Mediterranean region during the glacial period; the crowding together of the isotherms in southern Europe caused a great increase of storminess there, to which was due the torrential rains of which we have evidence.—Sir Gilbert T. Walker: On periodicity. Proposals that have been made in recent years for modifying Schuster's periodogram; a new criterion for the reality of a period, with some applications to meteorological data, is given.—Harold Jeffreys: On fluid motions produced by differences of temperature and humidity. It has been shown that the maintenance of a difference of temperature between parts of the same level surface in a fluid will necessarily maintain a permanent motion of the fluid, and that heating or cooling a fluid at an internal boundary will also maintain a permanent movement. A corresponding theorem is true for the supply of new constituents instead of heat. This result appears to contradict a theorem given by Sandstrom and Bjerknes, to the effect that a permanent motion is possible only if the place where the heat is supplied is at a lower level than that where it is removed; but the arguments of these authors involve an unstated assumption, which seems to be untrue. Sandstrom's experiment, in which no motion was observed in a tank under conditions suited to the production of a circulation, is capable of a dynamical explanation based on the slowness of conduction and the consequent confinement of the currents to narrow regions where they would be very difficult to observe. It appears unlikely that it will often be possible to proceed by analogy from this experiment to the dynamics of wind, for radiation and turbulence will always redistribute the heat in such a way as to produce general currents; but there may be some applications to ocean currents.—A. H. R. Goldie: Gustiness of wind in particular cases. Deals particularly with examples from the anemograph records of Falmouth Observatory during periods of S.W. wind. It was found that the time interval of the rise and fall of the anemograph pen and of the breaking of the waves on the shore approximated to seven seconds. A further investigation at Lerwick showed that the normal relation between "range of gusts" and "hourly mean wind," in the case of equatorial currents, is about one-third and nearly independent of velocity.

SHEFFIELD.

Society of Glass Technology, May 25 and 26.—W. E. S. Turner: The nature and constitution of glass. The abnormal properties recently observed in glass when heated in the annealing range (such as greatly increased thermal expansion, heat absorption, and modification of specific electrical conductivity; and the changes of density and refractive index on heat treating glass) have their counterpart in the changes of plasticity which glass exhibits when remelted or when the raw materials have considerable quantities of moisture or of certain salts present. Two fundamental factors are involved; molecular complexity and the presence of compounds in glasses.—G. Tammann: On glasses as supercooled liquids. A discussion of the influence of degree of undercooling, nucleus number, viscosity and other factors on the production of the glassy state. The customary soda-lime-silica glasses may be regarded as ternary mixtures of Na_2SiO_3 , CaSiO_3 and SiO_2 . The two components Na_2SiO_3 and CaSiO_3 crystallise readily, as do their mixtures, from which mixed crystals separate. With an excess of silica the nucleus number of these mixed crystals is reduced extraordinarily, so that mixtures with an excess of 8 per cent of silica or more solidify as glasses.—A. Q. Tool and E. E. Hill: On the constitution and density of glass. A glass is intermediate between the liquid and solid states. Its condition at ordinary temperatures may be considered as undercooled, not alone with regard to the process of crystallisation, usually known as the true solidification, but also with respect to the completion of many processes normal to the vitreous condition. The maximum density change observed was 1.10.—G. W. Morey and N. L. Bowen: The ternary system sodium metasilicate-calcium metasilicate-silica. The following new compounds have been found and their properties determined. The compound $2\text{Na}_2\text{O}$, CaO , 3SiO_2 , which melts incongruently, forming a liquid richer in Na_2SiO_3 and Na_2O , 2CaO , 3SiO_2 ; the compound Na_2O , 2CaO , 3SiO_2 , which has a congruent melting point at 1284° ; and the compound Na_2O , 3CaO , 6SiO_2 , which melts incongruently at 1045° , forming a mixture of wollastonite and a glass containing approximately 15 per cent CaO , 67 per cent SiO_2 .—R. W. G. Wyckoff and G. W. Morey: X-ray diffraction measurements on some soda-lime-silica glasses. (A preliminary note.) In some instances the broad bands thought to be characteristic of glasses have been found. In others narrow bands or lines have been obtained which are as sharp as the lines produced by crystals of colloidal dimensions.—Sir W. H. Bragg: The structure of quartz. Quartz changes its structure on passing through 575° . The high-temperature quartz is more symmetrical than the low, but the change is not severe. The four unknown quantities in low-temperature quartz reduce to one on passing to the high-temperature form; the silicon atoms are fixed, and the oxygen atoms must lie on certain straight lines. Attempts to fix the positions of the oxygen atoms can be made, based on intensity measurements. The most probable value shows, somewhat unexpectedly, that each silicon atom is at the centre of a regular tetrahedron of which the four corners are occupied by oxygen atoms. Assuming that the low-temperature quartz is not very different from the high-temperature quartz, the various twinings of quartz are readily accounted for.—Vaughan H. Stott: The viscosity of glass. Final relations between viscosity and composition, in which errors due to impurities or inaccurate compositions generally are not considerably greater than the errors of the viscosity determinations

themselves, cannot be obtained unless the glasses are prepared from materials of known purity and melted without contamination. This at present precludes the melting of large pieces of glass, and limits the design of viscosimeters

PARIS.

Academy of Sciences, June 15.—The president announced the deaths of Louis Gentil and Dr. Depage.—A. Haller and René Lucas: The rotatory powers of certain derivatives of camphor. Seven derivatives of camphor were studied. The specific rotatory powers were measured for seven wavelengths ($\gamma=6708$ to 4358) in four solvents (alcohol, benzene, carbon disulphide, cyclohexane). The rotatory power varied considerably with the solvent.—J. Costantin: An old symbiotic culture at the *Museum*.—Louis Lumière: Concerning the invention of the cinematograph. A claim for priority.—J. Haag: The probability in a circle.—Bertrand Gambier: Surfaces of which a finite or infinite number of asymptotics belong to a linear complex.—Maurice Fréchet: Abstract point transformations.—N. Lusin: The properties of projective ensembles.—P. J. Myrberg: Automorph functions.—B. Galerkin: The tensions of a prism having a rectangular isosceles triangle as base.—Paul Woog: Measurements of only friction. Data are given for various oils, either alone or with the addition of fatty acids.—André Metz: A relativist definition of simultaneity.—T. Peczański and G. Mokrzycki: Study of chemical compounds of salts in the electric arc. The distance between the electrodes of the arc and the intensity of the current were kept constant. Mixtures of oxides were placed in a crater on the positive electrode and the fall of potential measured. The curve obtained by plotting composition of the salt mixture against the volts indicated the formation of compounds.—N. Pariselle: Contribution to the study of the rotatory power and dispersion in the terpene series.—N. Pauthenier: The rotating arc between carbon electrodes.—Marcel Peschard: The magnetisation of ferro-nickel: saturations and atomic moments.—Jean Jacques Trillat: Study of soaps and fats by means of the X-rays.—A. Boutaric and Mme. Y. Manière: The influence of very small quantities of foreign substances on the stability of colloidal solutions. The addition of a small quantity of an electrolyte to a colloidal suspension may protect the solution against the flocculating action of an electrolyte, may accelerate the flocculation, or may be without effect. The results of experiments with two different electrolytes on a colloidal solution of sulphide of arsenic are given in the form of a table.—A. Damiens: An artificial magnesium silicate.—V. Auger and T. Karantassis: Researches on the complexes of stannic iodide. The compounds Rb_3SnI_6 , Cs_3SnI_6 , and $[\text{As}(\text{CH}_3)_4]_3\text{SnI}_6$ have been isolated.—P. Lebeau and P. Marmasse: The estimation of carbon dioxide and carbon monoxide. The carbon dioxide is removed by cooling with liquid air, which at the same time removes higher homologues of methane, ethylene, acetylene, and other gases likely to interfere with the iodine pentoxide reaction. The gas is then passed over iodine pentoxide at 150°C . and the carbon dioxide resulting from the oxidation of the monoxide again removed at -190°C . The method has been applied to the determination of carbon monoxide in commercial hydrogen and also to the search for carbon monoxide in gases from borings at Pechelbronn: the results in the last-named gases were negative. Air gave traces of carbon monoxide (less than 5 parts per million).—Paul Pascal: New complexes of iron derived from the triazines.—Charles Prévost: Methylphenylbutadune.—P. Gaubert: The spherulites of reamurite.—Louis Longchambon: The

polymorphic transformations of silica.—Jacques de Lapparent: The relations between the hydrocarbons and carbonates in silex and the phanites.—Maurice Jean: The nature of the internal liber of the seedling of *Convallaria tricolor*.—A. Tronchet: Polycotyly and schizocotyly in *Dimorphotheca pluvialis*.—M. Bridel and P. Picard: The preparation and properties of monotropitoxide. 60 grams of this glucoside have been extracted from 20 kilograms of bark of *Belula lenta*. Full details of its physical and chemical properties are given. It furnishes methyl salicylate, glucose, and xylose on hydrolysis.—René Jeannel: The homologies of the articulations of the leg in insects.—Stéphane Dombrowski: The permanent regimes of concentration in a convection current and its application to physiology.—Alphonse Labbé: The curves of growth of *Artemia aristina*.

ROME.

Royal Academy of the Lincei, April 4.—Leonida Tonelli: Problem of primitive functions.—Gabriella Armellini Conti: Observations of the position of the planet Uranus on the occasion of its conjunction with 96 Aquar.—O. M. Corbino and E. Persico: Secondary oscillations in a generator with a three-electrode lamp.—A. L. Herrera: Photomicrographs showing karyokinesis figures in metaformaldehyde crystals.—F. Sbrana: Characteristic property of polyharmonic functions and solutions of the equation of vibrating membranes.—Umberto Crudeli: Rutherford-Bohr triangular systems in relative equilibrium.—D. J. Struik: Irrotational waves in channels.—G. Ponte: Vulcanological investigations. Vulcanism causes a gradual impoverishment on the earth, not only of atmospheric oxygen but also of water vapour, similar to that which seems to have taken place with greater intensity on the moon.—E. Adinolfi: Influence of X-rays on the crystallisation of bismuth. X-rays exert on bismuth, during its crystallisation, an effect similar to, but distinct from, that caused by impurities, and varying with the hardness of the rays used.—Enrico Fermi: Relation between the constants of the infra-red bands of triatomic molecules. For these molecules, the three atoms of which must lie in one plane, the expression

$$\frac{I}{\Delta\nu_1} = \frac{I}{\Delta\nu_2} + \frac{I}{\Delta\nu_3}$$

is deduced for the relationship between the constant frequency differences of the lines in the infra-red band. The only triatomic molecule for which the necessary data are available is that of water vapour, and in this case the above equation holds within the limits of experimental error.—U. Sborgi: Electronic theory of the anodic behaviour of metals, especially of those exhibiting passivity phenomena.—G. Malquori: Mixed silver-copper basic salts. Investigation of the system $\text{Cu}(\text{OH})_2-\text{AgNO}_3-\text{H}_2\text{O}$ indicates the existence of only one mixed basic salt, which has the composition $3\text{Cu}(\text{OH})_2, 2\text{AgNO}_3, 3\text{H}_2\text{O}$, and is stable in the presence of silver nitrate solution of concentration not lower than 0.78 per cent.—Luigi Settimj: Transformation of nitrogen compounds (proteins) in preserved food produce. In food materials, whether tinned or in contact with the air, the insoluble nitrogen compounds undergo gradual transformation with production of an equivalent quantity of soluble nitrogen compounds.—P. Pasquini: Further considerations on the formation of the pecten in the development of the eye of *Gallus domesticus*. The evolution of the pecten in the development of the fowl's eye consists in a gradual lamination of the original pecten with consequent increase in its height in the vitreous humour; further, the lamina develops longitudinal folds, which increase its surface of contact with the vitreous body.—Umberto D'Ancona: Nerve endings in the somatic muscles of the decapod crustaceans.

Official Publications Received.

Annales de l'Observatoire Royal de Belgique. Troisième Série, Tome 2, Fascicule 1. Publié par P. Stroobant. Pp. 74 (Tournai: Imprimerie des Etablissements Casternan S.A.)

Studies from the Plant Physiological Laboratory of Charles University, Prague. Edited by Prof. Dr. B. Němec. Vol. 2, 1924. Pp. 108+5 plates (Prague)

Carnegie Institution of Washington: Eugenics Record Office. Bulletin No. 24. Body Build; its Development and Inheritance. By C. B. Davenport. Pp. 42. (Cold Spring Harbor, Long Island, N.Y.)

City and County of Kingston upon Hull, the Third Port of the United Kingdom. By T. Sheppard. (British Empire Exhibition, Wembley, 1925: Hull Civic fortnight, July 7th to 20th.) Pp. 40+10 plates. (Hull.)

Memoirs of the National Academy of Sciences. Vol. 20: The American Oaks. By William Trelease. Pp. v+255+420 plates (Washington: Government Printing Office.) 3.25 dollars.

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 6, 1924. 2: Nederbörden i Sverige. Pp. 159. (Stockholm.) 5 kr.

Annals of the (Mededeelingen van het) Transvaal Museum. Vol. 11, Part 2, containing: Native Dolls in the Transvaal Museum, by A. Radcliffe Brown; 1: Initiation of Girls in the Masiyeni District, Portuguese East Africa; 2: Note on the Decorations on Carved Wooden Food-Bowls from South Chopiland, Portuguese East Africa; 3: On some Ritual Objects of the Vandau in South Chopiland, Gaza, Portuguese East Africa, by E. Doia Earthy; On the Development of the "Epipubis" of *Xenopus*, by Dr. C. G. S. de Villiers. Pp. 99-135+plates 9-26. (Cambridge: Printed at the University Press.)

Department of the Interior: U.S. Geological Survey. Bulletin 751. Contributions to Economic Geology (Short Papers and Preliminary Reports), 1923-24. Part 2: Mineral Fuels. Pp. vi+321-326. Bulletin 760-C: Erosion by Solution and Fill. By Willis T. Lee. (Contributions to the Geography of the United States, 1923-24.) Pp. ii+107-121+plates 23-30. Bulletin 780-A: The Melrose Phosphate Field, Montana. By R. W. Richards and J. T. Pardee. (Contributions to Economic Geology, 1923, Part 1.) Pp. iv+32+2 plates. Water-Supply Paper 520-F: Temperature of Water available for Industrial Use in the United States. By W. D. Collins. (Contributions to the Hydrology of the United States, 1923-1924.) Pp. ii+97-104+plates 8-11. Water-Supply Paper 520-G: Some Floods in the Rocky Mountain Region. By Robert Follansbee and Paul V. Hodges. (Contributions to the Hydrology of the United States, 1923-1924.) Pp. ii+105-129+iv. Water-Supply Paper 523. Surface Water Supply of the United States, 1921. Part 3. Ohio River Basin. Pp. vi+816+2 plates. 80 cents. Water-Supply Paper 531. Surface Water Supply of the United States, 1921. Part 11: Pacific Slope Basins in California. Pp. vii+304+2 plates. 25 cents. Water-Supply Paper 536: Surface Water Supply of the New-Kanawha River Basin, West Virginia, Virginia and North Carolina. Pp. iv+282+2 plates. 35 cents. Water-Supply Paper 539. Geology and Ground-Water Resources of Townsend Valley, Montana. By J. T. Pardee. Pp. iv+61+2 plates. 15 cents. (Washington: Government Printing Office.)

Spisy vydavane Přírodovědeckou Fakultou Masarykovy Univerzity (Publications de la Faculté des Sciences de l'Université Masaryk). Čís. 47: System vodních toků na základě odtoku (Le système des eaux courantes d'après leur débit d'eau). Napsal Dr. Fr. Kolář. Pp. 97. Čís. 48: Bromonoyakam (La brome-novocaine). Napsal J. Frelka a J. Vitha. Pp. 22. Čís. 49: On the Growing Reactions, produced by the Change of Hydrogen-Ion Concentration in Germinating Roots of *Pharbitis hirsuta* Choisy. By Ferd. Herčík. Pp. 21. Čís. 50: Sur les probabilités géométriques. Par B. Hostinský. Pp. 26. Čís. 51: Výklad vzniku krátkých elektromagnetických vln v elektronových lampách (An Explanation of the Origin of Short Electromagnetic Waves in Valves). Napsal Dr. Josef Sahanek. Pp. 28. Čís. 53: La valeur osmotique et la réaction actuelle de l'eau du Golfe de Villefranche, à quel point sont elles constantes? Par Vladimir Morávek. Pp. 11. Čís. 54: Studie o inteligenci kočky, 2 (Studies on the Intelligence of the Cat, 2). Napsal Dr. Vladimír Teyrovský. Pp. 48. (Brno)

British Museum (Natural History). Famous Naturalists. Series No. 1, Set H. 2. 10 post cards in monochrome. (London: British Museum (Natural History).) 1s.

Bulletin of the American Museum of Natural History. Vol. 52, Art. 2: Scientific Results of the Expedition to the Gulf of California in Charge of C. H. Townsend, by the U.S. Fisheries Steamship *Albatross*, in 1911. 15: The Amphipoda collected by the United States Fisheries Steamer *Albatross* in 1911, chiefly in the Gulf of California. By Clarence R. Shoemaker. Pp. 21-61. (New York)

The Iwata Institute of Plant Biochemistry. Publication No. 1: Untersuchungen über den Japanlack. Von Prof. Rikō Majuma. Pp. x+154+3 Tafeln. (Tokyo) 2.50 dollars.

Scientific Papers of the Institute of Physical and Chemical Research. Nos. 24-25: X-ray Analysis of the Solid Solutions of Potassium Chloride and Potassium Bromide, by T. Sasahara. X-ray Analysis of Electrolytic Brass, by H. Nakamura. Pp. 277-292. 85 sen. No. 26: On the Mercury Line 2770 Å (1S-2p). By T. Takamine and M. Fukuda. Pp. 293-298. 25 sen. No. 27: Condensation of Nitrites with Thiamides. 4: Thiamide with Anilinochlorides. By S. Ishikawa. Pp. 299-304. 25 sen. (Tokyo: Komagome, Hongo.)

Meddelelser fra Kommissionen for Havundersøgelser. Serier Fiskeri, Bind 7, Nr. 7: On the Fishery of the Greenlanders. By Ad. S. Jensen. Pp. 39. 3 kr. Serier Fiskeri, Bind 7, Nr. 8: On the Influence of the Currents upon the Frequency of the Mackerel in the Kattegat and adjacent parts of the Skagerrak. By Dr. A. C. Johansen. Pp. 26. (København: C. A. Reitzel.)

New South Wales. Department of Mines: Geological Survey. Mineral Resources No. 33: The Gypsum Deposits of New South Wales. By Leo J. Jones. Pp. 43+14 plates. 2s. 6d. Bulletin No. 13: Chromium, Cobalt, Nickel, Zirconium, Titanium, Thorium, Cerium. By H. G. Raggatt. Pp. 17. 1s. Bulletin No. 14: Asbestos, Emery, Fluorspar, Fuller's Earth, Graphite, Phosphate, Tale, and Soapstone. By H. G. Raggatt. Pp. 31. 1s. Bulletin No. 15: Diatomite; Siliceous Earths and Sands. By E. J. Kenny. Pp. 18. 1s. (Sydney: Alfred James Kent.)

Lady Minto's Indian Nursing Association. Report for 1924. Pp. 167 (Simla.)

Year-Book of the Department of Agriculture, Ceylon, 1925. Pp. ii+52 +8 plates. (Peradeniya, Ceylon)

University of Illinois Engineering Experiment Station. Bulletin No. 147. Investigation of Antennae by Means of Models. By Prof. J. Tykocinski-Tykociner. Pp. 60. (Urbana, Ill.) 35 cents.

New York Zoological Society. Report of the Director of the Aquarium. (Reprinted from the Twenty-ninth Annual Report of the New York Zoological Society.) Pp. 15. (New York.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 18, N.S., Nos. 5-6. 5: The Interpretation of certain Empirical Standards in their Application to Irish Butter, by George Browne; 6: The Theory of Variation of Flow in Pipe-lines with Surge Chambers consequent on Variation of Load on Hydraulic Turbines operated Therefrom, by H. H. Jeffcott; 7: The Variations in the Quantity of Food required by Cattle for Maintenance and Fat Production with different Kinds of Rations, by James Wilson; 8: The Identity of Vitamin A. The Comparative Effects of Human and Cow's Milk, by Harold Pringle; 9: On the Photo-electric Measurement of Submarine Illumination, by H. H. Poole. Pp. 49-115. (Dublin: Royal Dublin Society; London: Williams and Norgate, Ltd.) 5s.

Report of the Fourth International Seed Testing Congress: Compte rendu du 4^{ème} Congrès international d'essais de semences: Bericht über den IV Internationalen Kongress für Samenprüfung. in/4 Cambridge (England), 7-12 VII 1924. Pp. 227. (London: H.M. Stationery Office) 11s. 6d. net.

Diary of Societies.

SATURDAY, JULY 18.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (at Town Hall, Folkestone). at 11 A.M.—A. E. Nichols. Municipal Works at Folkestone.—E. C. Fawcett: Folkestone's New Sea Outfall Works

BIOCHEMICAL SOCIETY (jointly with the Agricultural Education Association) (at University College, Reading), at 5.—Prof. R. H. A. Plimmer. The Action of Nitrous Acid upon Amides and some Amino Compounds.—W. J. N. Burch. Some Esters of Phosphoric Acid.—Matick and Wright: The Influence of Administration of certain Salts on the Inorganic Constituents of Milk.—E. Ponder and W. W. Taylor. The Conductivity of Cell-suspensions.—G. D. Thacker and J. R. Marrack. The State of Calcium in Body Fluids.

MONDAY, JULY 20.

ROYAL SANITARY INSTITUTE (at Edinburgh), at 5.—Sir John Gilmour, Bart. Inaugural Address.

TUESDAY, JULY 21.

ROYAL SANITARY INSTITUTE (at Edinburgh), at 10 A.M.—Meetings of Sections and Conferences: Sanitary Science, Industrial Hygiene, Engineers and Surveyors, Sanitary Inspectors.—At 8 P.M.—Sir Leslie Mackenzie. The Problem of Psycho-physical Fitness (Lecture)

BRITISH MEDICAL ASSOCIATION (Annual Meeting) (at Bath)

WEDNESDAY, JULY 22

ROYAL SANITARY INSTITUTE (at Edinburgh), at 10 A.M.—Meetings of Sections and Conferences. Sanitary Science, Personal and Domestic Hygiene, Representatives of Sanitary Authorities, Medical Officers of Health.

BRITISH MEDICAL ASSOCIATION (Annual Meeting) (at Bath).

THURSDAY, JULY 23.

ROYAL SANITARY INSTITUTE (at Edinburgh), at 10 A.M.—Meetings of Sections and Conferences: Engineering and Architecture, Maternity and Child Welfare (including School Hygiene), Port Sanitary Authorities, Veterinary Inspectors, Health Workers.—At 8 P.M.—Dr. C. Porter: The Citizen and the Citizen's Health (Popular Lecture).

BRITISH MEDICAL ASSOCIATION (Annual Meeting) (at Bath)

FRIDAY, JULY 24.

ROYAL SANITARY INSTITUTE (at Edinburgh), at 10 A.M.—Meetings of Sections and Conferences: Engineering and Architecture, Maternity and Child Welfare (including School Hygiene), Veterinary Inspectors, Health Visitors.

ROYAL ASTRONOMICAL SOCIETY, at 4.30.—Special General Meeting

ARISTOTELIAN SOCIETY, MIND ASSOCIATION, AND OXFORD PHILOSOPHICAL SOCIETY (Joint Session) (at Balliol College, Oxford), at 5.—Annual General Meeting of the Mind Association.—At 8.30.—Prof. H. Wildon Carr, Prof. A. Wolf, and Prof. C. Spearman: Symposium: The Nature of Intelligence.

BRITISH MEDICAL ASSOCIATION (Annual Meeting) (at Bath).

SATURDAY, JULY 25.

ARISTOTELIAN SOCIETY, MIND ASSOCIATION, AND OXFORD PHILOSOPHICAL SOCIETY (Joint Session) (at Balliol College, Oxford), at 10 A.M.—C. R. Morris, Dr. Dorothy Wrinch, and Prof. L. J. Russell: Symposium. The Concept of Energy.—At 2.30.—Dr. Ivy Mackenzie: The Biological Basis of the Sense of Time.—At 8.30.—Prof. J. A. Smith, Prof. A. D. Lindsay, and Dr. F. C. S. Schiller: Symposium: Croce's Theory of the Practical Nature of Science.

SUNDAY, JULY 26.

ARISTOTELIAN SOCIETY, MIND ASSOCIATION, AND OXFORD PHILOSOPHICAL SOCIETY (Joint Session) (at Balliol College, Oxford), at 2.30.—P. E. More, Prof. W. D. Ross, and Prof. G. Dawes Hicks: Symposium: Plato and Aristotle.—At 8.30.—J. MacMurray, C. E.-M. Joad, and A. H. Hannay: Symposium: Is Art a form of Expression or of Apprehension?



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The Future of the British Patent Office.

I.

THE British patent system suffers from certain rather serious defects which prevent it from fulfilling adequately its function as a stimulus to invention and as an incentive to the development of new manufactures. It is the purpose of the present article to discuss one of these defects, namely, the restricted character of the investigation for novelty which is carried out by the Patent Office, and to direct attention to the need for fresh legislation on this subject. Wide differences of opinion are likely to exist as to the form the remedy should take, since the relative cost of any schemes which may be put forward will depend on the degrees of thoroughness characterising the searches for which they respectively provide. The view here advocated is that an extremely high degree of thoroughness will repay the expenditure which it involves, but we shall have served our purpose if we succeed in directing attention to the principal questions on which a decision will have to be taken when the present state of the law comes to be amended.

At the present time the situation in Great Britain is as follows. When a capitalist proposes to work a given patent, it is necessary for him to expend a certain outlay in plant, buildings and business organisation. Before taking the financial risk involved, he naturally desires to have some degree of assurance that he can uphold his patent in the courts, that it will not be invalidated after he has committed himself irrevocably to his venture. In the present state of the system, quite apart from the possibility of "prior user," which plays a small and diminishing part in such matters, and of "lack of subject matter," which does not entitle the patentee to much sympathy, he cannot have any such assurance. For at any time after a patent has been granted by the Patent Office, it may be invalidated on the ground that, unknown to the patentee, an invention similar to his had previously been "made available to the public in some document published in the United Kingdom," such as a foreign patent specification or a technical journal.

This state of affairs is keenly felt in manufacturing circles at the present time. It discourages the investment of capital in new manufactures at a time when unemployment and foreign competition demand the fullest exploitation of new means for creating wealth, and it hampers inventors in turning to advantage their patent rights. It is true that as regards anticipation by prior British specifications of the previous fifty years, the Patent Office does make a search which is marked by characteristic British thoroughness, but that search is a good thing spoiled, for it covers only a

fraction of the documents from which anticipations may afterwards emerge.

Various remedies for this state of things might be proposed. For example, if the Comptroller were simply to be empowered to enforce amendment to meet what are now called "extra-statutory citations," probably some sort of an extended search would be evolved in the course of a few decades, in an attempt to give fuller effect to these new powers. Or again, as Mr. W. J. Tennant once suggested,¹ the British search might be abandoned and the staff might devote itself to the formation of a universal index, in which applicants or their agents could search for themselves over a wide field. Or if the present examining staff were to be diluted with personnel of inferior qualifications working under its direction, a comprehensive search of moderate cost and low efficiency could be instituted within a reasonable time. We suggest, however, that the thing is worth doing well, and that means of a practicable character can be found to meet the cost of a far more ambitious scheme. We propose that the Patent Office should undertake to search over substantially the whole area in which anticipating documents may be found, and that it should carry out this investigation with the same thoroughness that at present characterises its search amongst British specifications.

In order to help in reducing the gap between the area covered by the search and that contemplated in the legal grounds for invalidation, the latter might be contracted somewhat. For example, it is only in the most academic sense that an invention can be said to be anticipated by an identical invention published twenty-five years ago in German and then forgotten. In fact, invalidation by publication might reasonably be restricted, in the case of foreign specifications, to a period of twenty years, at all events during the experimental stage of the extended search. The effect of publication in periodicals might be restricted to a like period, since their essential subject matter passes in the course of time into text-books. It might even be considered reasonable to rule that prior publication in any language other than English, French or German should not be deemed to invalidate a patent; and, again, it is by no means certain that the present law with regard to prior user gives the fairest balance between the rights of all the parties concerned.

All the points referred to above require careful consideration by the patent lawyers, and if their decision be favourable, the scope of the extended search can be narrowed accordingly without defeating the object of the latter. For our present purpose we shall assume that for all practical ends it will be sufficient to

search amongst the patents published in the Dominions, France, Belgium, Germany, the United States, and Switzerland for the preceding twenty years, and to search for a like period all the relevant periodicals at present taken by the Patent Office Library, together with up-to-date text-books. It would also be desirable for the Patent Office examiners to visit works regularly and make notes of standard practice; for apart from the utility of such notes, this plan would keep the outlook of the Office essentially practical and prevent it from becoming too academic.

The advantages to be gained by instituting an extended search are many and important: a few of them may be pointed out here. As has already been argued, the confidence which it would establish would stimulate invention and the development of new manufactures, for it would remove the principal cause of the uncertainty which at present hangs over the patentees of obviously useful and ingenious inventions. There is no need to labour this point, which will readily appeal to manufacturers; but it is important to note the effect of any step of this kind in reviving industry and so helping employment. Then again, at the present time, inventors who wish to protect their inventions abroad have actually to make application in the countries they have selected before they can have any idea of the anticipations which are likely to be cited against them there, and the process of amending to meet the requirements under this head of the American or the German Patent Office is a troublesome and expensive one, which could largely be avoided if the specification had originally been drawn up in the light of full knowledge. Internationally, too, the value of the British patent would be so much enhanced that it would acquire a dominating position in the patent systems of the world. Applications which at present are sent from all parts of the world to Germany or the United States in order to obtain the results of a universal search might then come to Britain, provided that the present standard of thoroughness were maintained intact.

It has been suggested that patents should be granted for the British Empire as a whole, so as to avoid the expense and labour which are incurred when a separate application has to be made in each of the component countries of the Empire. A conference on this subject was held in 1922, but none of the technical staff of the Patent Office was present, and those who advised the chairman on behalf of the mother country were without personal knowledge of the essential work of examination and search. As might be expected in these circumstances, the conference failed to handle successfully the extremely delicate technical question of an Empire search, in which the dignity of the

¹ W. J. Tennant, Presidential Address, Transactions of the Chartered Institute of Patent Agents, 1917-18, vol. 36, p. 41

Dominions was concerned; in consequence, proposals were adopted which failed to win over the Dominion Governments, and the conference has proved sterile. To some small extent, however, the advantages which would have been gained by the institution of a competently planned Empire patent would be conferred by an extended search; at all events, a patentee who thought of protecting his invention in the Dominions would be able to find out beforehand whether any prior Dominion patent stood in his way.

The extended search would also make possible certain innovations which would cheapen patent litigation in the same way that the institution of Quarter Sessions cheapens criminal procedure. It would make it practicable to empower the Patent Office to deal with certain issues which at present are reserved for the courts, and in particular to grant suitably restricted certificates relating to the validity of patents, having an effect on costs similar to that of the certificates of validity at present granted by the courts. For during the five years 1920-1924, when the Patent Office sealed 83,166 patents and the Comptroller (together with the senior members of the scientific staff who share his judicial duties) gave decisions under the "novelty sections" (7 and 8) of the Patent Acts in 8831 hearings, there were only 7 successful and 3 partly successful appeals against those decisions. Hence no hesitation would be felt in entrusting the Patent Office with wider powers, provided that its Hearing Officers were given access by means of an extended search to the requisite range of facts. The effect of cheapening patent litigation in this way would be to protect poorer inventors against intimidation by the wealthy owners of bad patents, since the latter's bluff depends for its effect on the costliness of patent actions.

The last advantage of an extended search to which we need refer is one that especially concerns research workers. At present there is no very easy way of finding out the precise state of any technical art before embarking on research in connexion with it, and as a result labour is sometimes wasted in repeating work which has been done before, while investigators and inventors are deprived of knowledge which might be of the greatest value in solving for them various problems of design incidental to their main objectives. Now if the Patent Office were to undertake the kind of search we have indicated, it would become an encyclopædic source of information as to the current state of invention in all parts of the world, and the examining staff would become a body of experts able to supply, at short notice, fully documented information as to the methods which have been proposed and the problems that have to be solved in every kind of manufacture. If this informa-

tion were to be available on payment of a suitable fee *before* the filing of a complete specification, it would enable inventors to put their inventions into the best practicable form.

In this connexion, considerable interest attaches to an article in *La Propriété Industrielle*, May 31, 1925, p. 93, urging the formation of an international classification, so that indexes should have the same sub-headings in all countries. That this in itself is not practicable can best be seen by means of an example. About 150 different varieties of the ordinary tumbler switch are comprised under the appropriate British sub-heading, and in order to determine precisely which switches shall and which shall not be included, a rigorous definition is necessary. The definitive heading adopted is:

Electric switches, etc.,

kinds, etc.,

snap-action switches (springs during a single on or off operation are first strained and then relaxed, to assist or to produce the switching movement) (*including* like snap action switches with gravity action, and snap action details of switches of all types)

with operating levers and turn members having limited stroke.

In the United States, on the other hand, most tumbler switches would go into the file 200 (67), the heading of which is snappy rather than definitive, namely:

Electricity circuit makers and breakers

snap

oscillating contact

double snap

It will be clear at a glance that these two files, though they overlap, do not necessarily cover the same ground. Now it sometimes happens that while attending an interview in an overcrowded room an inventor will overhear two examiners wrangling about classification. Let any one who has had this experience picture to himself an attempt to secure mutual agreement, by correspondence between the 160 patent offices of the world, as to (a) a definition of what is to be included in the file for tumbler switches, and (b) the manner in which that file should be subdivided. However, we may concede the main contention of the article referred to—which is that a universal index would be of the utmost value to the whole world—while at the same time we hold that a single nation must give effect to it.

We have now only to show that the scheme that has been outlined is practicable and that the cost can be met in an acceptable manner. For that purpose an examination of published statistics has been made, and the results will be described and considered in a further article.

Meteoric Astronomy.

Meteors By Prof Charles P. Olivier. Pp. xix + 276 + 23 plates. (Baltimore Williams and Wilkins Co., London · Bailière, Tindall and Cox, 1925) 30s. net

A GREAT part of the most valuable work in recent years on meteoric astronomy has appeared in periodicals published in different countries. As many of these are inaccessible to the average reader, Dr Olivier's book reviews a number of the most important of the articles appearing in the various journals; the more mathematical parts are segregated, so that the non-mathematical reader can omit these without losing the continuity of the work. The researches of Dr Olivier and the American Meteor Society for several years on meteoric astronomy, the results of which are included in the book, render it both valuable and interesting, though probably differences of opinion will arise, especially amongst English meteor observers, on some of the conclusions attained.

In the first chapter, "Historical Introduction," we have a brief account of the fall of meteors from the earliest times, the first record being found in the Book of Joshua, chap. x. The author believes that the narrative describes the fall of meteorites rather than hailstones. We may remark, however, that Josephus affirms that thunder and lightning accompanied the phenomenon, which may indicate a fall of hailstones of unusual size, not meteorites. The second chapter describes the methods for observing meteors, including those depending upon photographic work. The mechanical apparatus of Rev. M. Davidson, referred to on p. 14, and stated to have been described in the *Journal of the British Astronomical Association*, 30, p. 92, is not, however, used for observing meteors, but for determining their real paths from the results of a double observation.

Five chapters are devoted to discussing some of the chief showers, the Leonids, Perseids, Lyrids, Andromedids, Aquarids, and the meteors associated with the Pons-Winnecke comet. In connexion with this first shower and its well-known relation to Tempel's comet, there is an obvious error on p. 40, where it is stated that the orbit has a major axis of 10.34 astronomical units, and the aphelion point is 18 from the sun, but due to the inclination of the plane of the orbit to that of Uranus—about 16° —the meteors could never approach the planet within 5 astronomical units. The *semi* major axis is 10.34, and though the inclination is 16° , yet at the ascending node the comet is about 18.8 from the sun, so that the meteors could come quite close to Saturn at times. It appears as if Dr Olivier considered the axis major to be inclined at 16° , and then concluded that the comet would be 18 sin 16°

from the plane of Saturn's orbit when at aphelion. A very important point is discussed in connexion with the Perseid shower—the shift of the radiant by about 1° in longitude each night. Denning was the first to show that there was this undoubted movement from July until about August 20, but Brédikhine held the view that the radiants observed in July and those probably after August 19 belonged to other streams or were partly chance accordances. The work of the American Meteor Society, however, substantiates the existence of radiants in the positions assigned by Denning to the Perseid radiant from July 28 until August 18, though from July 21 until 27 the data are insufficient to affirm or deny Denning's positions. It seems strange that some European observers should find little or no evidence of a regular motion of the Perseid radiant: English observers have not generally disputed Denning's results.

In Chap. VIII it seems to us that some of Dr. Olivier's criticism is unfair. In 1910 he announced, from observations of the Aquarids, that the connexion between Halley's comet and the η Aquarids was first definitely proved. The radiant is not given in this chapter, but in a previous work, "175 Parabolic Orbits deduced from over 6200 Meteors," published in 1911, the radiants are given on the dates May 4, 6, 11, as $334^\circ-3^\circ.4$, $337^\circ-7^\circ.0$, $6^\circ.342^\circ-0^\circ.6$ respectively. In the British Association Report for 1874, p. 349, Herschel pointed out the probable connexion, and also in the *Monthly Notices of the Royal Astronomical Society*, 1876, though Tupman's radiant $325^\circ-2^\circ.5$ on May 1-3 was a considerable distance from the theoretical position, $337^\circ-0^\circ$ on May 4. In the *Mon. Not. R. A. S.*, 1886, Denning states, from his radiant $337^\circ-2^\circ.5$, April 30-May 6, "the identity of the two orbits seems placed beyond doubt." The fact that Denning in 1899 was cautious enough to use the expression "probably associated with Halley's Comet," scarcely justifies Dr. Olivier in claiming priority by saying he "definitely proved" the connexion in 1910. Again, on p. 76, in discussing eight radiants, the author submits that Tupman's are the only scientifically observed ones, yet on April 29 Tupman's radiant is $329^\circ-2^\circ$, and on May 2-3 it is $325^\circ-2^\circ$. Now, as Dr. Olivier holds that the radiant moves about 1° in longitude each day, then Tupman's radiant on April 29 should correspond closely to $332^\circ \pm 0^\circ$ on May 3, a position far from $325^\circ-2^\circ$ found then. One cannot describe this as one of "the only thoroughly scientifically observed radiants." Indeed, Nos. 4 and 7 by Denning and Corder correspond far more closely with the theoretical position for Halley's comet. In addition to the points raised concerning the Aquarids, this chapter also discusses the meteors of Pons-Winnecke's comet, but the orbits published in the *Monthly Notices of the Royal Astronomical Society*, 77, 1916, are not

reproduced, as it is thought that the elements might be improved by another treatment and by having certain corrections applied. In the paper referred to, it is thought that the shower extended from May 20 until July 10, though to the present writer this seems very doubtful, and possibly the author may modify his views later when he hopes to make this the subject of a new research.

A considerable amount of discussion takes place on the question of stationary radiants, and a summary of the works of Von Neissel, Tisserand, Turner, Herschel, Brédikhine, Pickering, Plummer and Davidson is given. Dr. Olivier, as is well known, does not believe that stationary radiants as a rule exist, though the researches of those just mentioned show the possibility of such under certain conditions. He admits, however, that approximately stationary radiants near the ecliptic may exist for considerable periods of time, but does not think that the same applies to radiants with high latitudes. Denning was convinced of the existence of stationary radiants before any theoretical justification for them was advanced, and though most of these apply especially to radiants near the ecliptic, there is the possibility of reasons being given for others in the future.

Those possessing elementary mathematical knowledge will find much interesting reading in such subjects as meteor orbits, real heights, perturbations of orbits of streams, formation of meteor streams from comets, etc. The methods of computing orbits are almost identical with those published by Lehmann-Filhès, and many sections of Schiaparelli's "Sternschnuppen" are reproduced. The real heights of meteors are found by Schaeberle's method, and an example is given in Chap. xv. It seems to us that it is unnecessarily laborious, and the use of a celestial globe saves much time in this work. Extreme accuracy cannot be attained, especially in finding the height of the beginning of a meteor, as the observers in different places do not usually see its commencement exactly at the same instant. By taking the azimuth and altitude of the beginning and ending on a celestial globe and then using a good map, paths of meteors can be quickly found. Davidson's apparatus described in the *Journal of the British Astronomical Association*, 30, p. 92, is useful where one of the observers is doubtful of the position of the beginning or ending, but the direction of flight is well known. The instrument itself automatically adjusts the ill-defined position.

Dr. Olivier's work covers practically every branch of meteoric astronomy, and should be extremely useful to those interested in this department. The frequent use of split infinitives may irritate some readers, but this literary defect cannot be said to detract from the scientific value of the book.

Cults and Customs in San Cristoval.

The Threshold of the Pacific: an account of the Social Organisation, Magic, and Religion of the People of San Cristoval in the Solomon Islands. By Dr. C. E. Fox. (The History of Civilisation Series.) Pp. xvi+379+14 plates. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, Inc., 1924.) 18s. net.

IT was a more than fortunate chance that threw together the late Dr. W. H. R. Rivers and Dr. Fox while on a voyage to San Cristoval in the *Southern Cross*. It was then that the interest of the latter in anthropology was aroused by Rivers's genealogical investigations. These he regarded at first with some amusement, but as time went on he came to be drawn to the study of the customs and beliefs of the people among whom his work lay as a missionary, with as serious a purpose as that which inspired Rivers himself.

Anthropologists have long been aware that this book was in preparation. The manuscript was in Rivers's hands at the time of his death; but the work of editing was still unfinished, and the task of completing it has devolved upon Prof. Elliot Smith with the assistance of Mr. W. J. Perry. The expectations which had been aroused by the publication of part of Dr. Fox's material in the *Journal of the Royal Anthropological Institute* are fully justified by the completed work, which, it is no exaggeration to say, will take high rank among the works which record first-hand study of primitive peoples. Dr. Fox writes with the intimate knowledge which comes from careful inquiry as well as long acquaintance with the subject matter; yet he retains a freshness of observation undimmed by familiarity, which serves to carry his reader through a mass of detail without even a suggestion of weariness.

San Cristoval, which lies at the south-eastern end of the Solomons, is divided into several large districts, which differ considerably from one another both in social organisation and in beliefs and custom. Broadly speaking, the west end of the island, which Dr. Fox, extending the strict geographical application of the name, calls Arosi, and Kahua—the eastern end—together with the outlying small islands, differ from the central area Bauro in that they are organised on a totemic basis. Bird clans occur in the west in Arosi, aquatic clans to the east in Kahua, and both are found along the coast of the central part. In the district of Bauro, of which, however, Dr. Fox knows part only, the people of the interior have a dual organisation. Although there are some totemic clans on the coast of this district, as mentioned above, it is clear that the dual organisation underlies them, as might perhaps be expected.

The relationship terms in this district appear to differ from those in any other part of Melanesia in that all the terms and all names have prefixes to distinguish sex, the term used depending upon the sex of the person to which it is applied.

Dr Fox has paid special attention to the very interesting serpent cult, which has its home in the Bauro district. This cult has many peculiar features, well brought out in the legends connected with the snake which he quotes. Pools, rocks, and waterfalls or large trees are thought to be the abode of *hi'ona*, *higona*, or *figona*, the last being the term Dr Fox prefers to use throughout. These spirits are never seen, but others, the chief *figona*, had a serpent incarnation only. In this they differ from the *Adaro*, some of whom are ghosts; others, spirits who have never been men. These could take the form of men, dogs, birds, snakes, trees, or clouds. The *figona*, however, seem to be connected with stone worship in addition to their serpent incarnation, for they could take the form of, or withdraw into, stone. Of these serpent incarnations, Dr Fox regards one known as *Agunua* as "almost like a supreme spirit" and partaking in some sort of the nature of a divine demiourgos. It would appear that particular *figona* are regarded as local representations of *Agunua*. Dr Fox is also inclined to the view that the worship of *Agunua* was once widespread. On the whole, however, although the legends of *Agunua* are connected with the creation of certain things, as, e.g., the coming of fire, he scarcely functions in the rôle of creator, and the evidence upon which supremacy is attributed to *Agunua* appears to be too slender for any positive conclusion.

Dr Fox has naturally paid considerable attention to the system of relationship—a study for which Rivers's genealogical method has done so much. His results, however, are an illustration both of the strength and weaknesses of that method. He gives a very candid account of the difficulties into which he was led until he discovered the discrepancies introduced into his information by the practice, which Rivers himself noted, of marriage and adoption out of the correct generation. One result of the custom of adoption—amusing enough to us, although it offers nothing incongruous to the native mind—is that a boy may be adopted as a father or a grandfather, and thus stand in either of these relations to those who are his coevals.

"The Threshold of the Pacific" can be considered under two aspects. On one side, Dr Fox records the results of his observations, and in this his work is deserving of the highest praise. On the other, he seeks to draw ethnological conclusions from his material; and what is really unfortunate, these two aspects are not kept rigorously asunder as they should be. The

reader, therefore, may perhaps be pardoned if he has an uneasy feeling that Dr. Fox, in dealing with certain remarkable features in the culture of the San Cristoval, such as the custom of embalming, the modes of burial, the winged serpent belief, etc., has allowed his judgment to be unduly influenced by analogies which undoubtedly may be found in ancient Egypt. He argues that San Cristoval has been peopled by four distinct groups: (1) The Amwea moiety of the dual organisation, (2) the Atawa moiety of that organisation; (3) the Abarihu, part of whom constitute the Araha ruling group; and (4) the people who practise cremation. So far this would seem a not improbable interpretation of the evidence. Dr Fox, however, goes further and points out that many customs of the Araha exhibit similarities to the cultural complex which has been attributed to the people of the "archaic civilisation" of Indonesia as described by Prof. Elliot Smith, and make strongly for their identification with that hypothetical culture. This, as will be seen from a careful perusal of Dr. Fox's final chapter, has involved him in considerable difficulties, owing to the fact that certain elements of that culture are entirely absent, while others, though present in San Cristoval, do not attach particularly to the Araha. The discrepancy is apparent to Prof. Elliot Smith, who suggests an alternative explanation in his introduction.

It is not proposed to enter here into a discussion of the significance of the similarities of the Araha culture to those of the "archaic civilisation," such as embalming, the burial mounds (called "mastaba" in a diagrammatic illustration of a burial mound, but not in the text) with superimposed dolmens, the winged serpent *Hatubwari*, the "double" which goes into a stone statue, and the like. It is well known that Dr. Rivers and Prof. Elliot Smith were both greatly impressed by the evidence collected by Dr. Fox which appeared to point to the culture of ancient Egypt as the nearest analogy. How far Dr. Fox's judgment may have been influenced by that fact it is impossible to estimate, but in the preface it is stated:

"Rivers was virtually Fox's only channel of communication with the ethnological world. Hence it is no matter for surprise that the isolated worker in distant Melanesia was profoundly swayed by Rivers' views, even in some cases when his own evidence came into conflict with them. In respect of these points of difference, it is unfortunate that Dr. Fox is so far away as to make discussion even by letter virtually impracticable. Hence I have felt obliged to leave certain of his statements in a form which I feel sure he would have agreed to modify, had discussion been feasible."

This statement is a little perplexing and might, with advantage, have been made more precise.

X-rays in Research.

La technique des rayons X. Par Dr. A. Dauvillier. (Recueil des Conférences-Rapports de documentation sur la Physique, vol. 10, 2^e série. Édité par la société *Journal de Physique*) Pp 195. (Paris: Les Presses universitaires de France, 1924.) 22 50 francs

DURING the first seventeen years after the discovery of X-rays in 1895, the development of apparatus for their production was chiefly influenced by the requirements of medical radiologists. Progress was rapid, and attempts at standardisation were swept away by a flood of ideas, applications, and devices. In the year 1912, however, a great advance in a new and purely physical direction was made possible by the work of Laue. Following this lead and under the inspiration of Rutherford, Moseley, Bragg, de Broglie, Duane, and others, physical research in which X-rays play a conspicuous part has now become of outstanding importance.

Since the immediate questions opened up by this work and by the problems ever before the medical radiologist differ somewhat in their scope and aim, it is not surprising that the appliances evolved in the laboratory for X-ray research work should have come to be very different from those used to-day in medical practice. This evolution is traced out by Dr. Dauvillier in his book. It is essentially a work for those who are already somewhat familiar with the subject, and to whom the general information given at the beginning will serve as a useful reminder of the progressive steps by which our present knowledge has been attained. On p. 35, however, the author is in error in attributing the first X-ray tube with slanting anticathode to Mr. A. A. Campbell Swinton instead of to Sir Herbert Jackson, who, in fact, actually made it with his own hands.

After referring to the construction of "gas" tubes and their mode of regulation, we reach the section of the work dealing with the hot cathode device due to Lilienfeld and Coolidge. It is here that the value of the book is most apparent, for the author has brought together much valuable information which was previously scattered, and therefore only accessible with difficulty. The applications of the hot cathode idea are considered in detail, and the modification of the usual radiographic type of tube to suit the special requirements of the laboratory is explained and illustrated. We thus have the advantage of studying the design of the modern tubes employed in X-ray spectroscopy, with full notes of the difficulties to be met with in their use and the means of overcoming them, written by one who is himself an accomplished experimenter. Incidentally,

since most of these tubes require to be continually exhausted of gas while in action, the author refers to the latest pumping methods, and gives an interesting description of a tube with liquid anticathode and also of one with a gaseous target.

The medical radiologist is, of course, gaining valuable data from the purely physical work on absorption and scattering of X-rays under various conditions, as well as from the study of the energy distribution in X-ray spectra, and he is also beginning to realise the desirability of utilising for his work a type of electrical plant that will provide a constant current at a pressure of, say, 200,000 volts. Apparatus of this kind was first set up in the United States for careful physical work on X-ray spectra, and a modification of the plan then adopted, and due largely to Dr. Dauvillier himself, is now being developed in France. Germany, too, is actively manufacturing constant current high voltage plant for X-ray work. The author has therefore wisely devoted a whole chapter to this important matter.

With regard to protection, there is no mention of the recommendations of the X-ray and Radium Protection Committee which were issued in 1921, and the author is perhaps too definite (p. 114) in referring to what he considers a safe minimum radiation intensity. It is felt by many that we are not yet quite sure as to the biological effects of exposure to a very feeble radiation over long periods of time continuously.

The book deals towards the end with the vexed question of X-ray measurement, a subject to which Dr. Dauvillier has himself made some notable contributions. Finally, there are brief references to medical, industrial, or other applications of X-rays.

We recommend this work to all physicists who are engaged upon researches in which a technical knowledge of the subject is indispensable. It is clearly written, well arranged, and fully illustrated. Its use would be still further enhanced, however, by the provision of a more adequate index, or at least the revision of the existing "table des matières," where in several instances the page numbers do not agree with the references in the text.

C. E. S. P

The New Principia.

Principia Mathematica. By Prof. Alfred North Whitehead and Bertrand Russell. Second edition. Vol. 1. Pp xvi+674. (Cambridge: At the University Press, 1925) 42s. net.

THE great achievement of the authors of "Principia Mathematica" is to have deduced mathematics by strict symbolic reasoning from a small number of logical propositions. This was previously attempted

by Frege in his "Grundgesetze der Arithmetik," but without success. For his axioms, like those of most logicians, were found to imply contradictory consequences, such as the famous paradoxes of the theory of aggregates. In particular, both the thesis and antithesis of the well-known contradiction about the class of all classes not members of themselves could easily be deduced from Frege's primitive propositions.

To escape this difficulty, Prof. Whitehead and Mr. Russell invented the theory of types, by which both the thesis and antithesis of such contradictions were ruled out as strictly nonsensical. By means of this theory they succeeded in constructing a system adequate for the deduction of mathematics and, apparently at least, free from contradiction. But this system was not entirely satisfactory: apart from the reductions in the number of primitive ideas and propositions, which have been effected by Sheffer and Nicod, the principal need for improvement was in connexion with the "Axiom of Reducibility." This axiom was introduced to justify a common form of mathematical reasoning, which would otherwise have been invalidated by the theory of types.

Unfortunately, the axiom is by no means obviously true, and was only put forward because no less objectionable assumption could be found which would justify the ordinary theory of real numbers and Dedekind section. This unsatisfactory state of things led Weyl and others to reject the theory of real numbers as groundless, and to try to construct a truncated analysis without using Dedekind section. Consequently the main interest of this new edition of "Principia Mathematica" lies in its treatment of the axiom of reducibility.

The authors have left the text of the work unaltered, to avoid the enormous labour of changing the references throughout three volumes, but have added a new introduction and appendices. The introduction contains a much simplified exposition of the theory of types, and the outlines of a new theory in which the axiom of reducibility is replaced by a new assumption suggested in the first place by Wittgenstein for philosophical reasons. This new assumption is entirely unobjectionable, because it is of such a form that it could be made a mere matter of definition. Unfortunately, it is not nearly so fertile as the axiom of reducibility, and whole branches of mathematics, such as the theories of infinite cardinals and ordinals, of mathematical induction, and of real numbers and Dedekindian series require a new treatment.

The authors have only succeeded with this new treatment in one of the important cases, namely, mathematical induction, of which a full account is given in one of the appendices; there with great ingenuity and arguments involving functions of the fifth order, all

the usual theorems are established without using the axiom of reducibility. On the other hand, the authors confess that "There is, however, so far as we can discover, no way by which our present primitive propositions can be made adequate to Dedekindian and well-ordered relations. . . . It might be possible to sacrifice infinite well-ordered series to logical rigour, but the theory of real numbers is an integral part of ordinary mathematics, and can hardly be the object of a reasonable doubt. We are therefore justified in supposing that some logical axiom which is true will justify it. The axiom required may be more restricted than the axiom of reducibility, but, if so, it remains to be discovered." It seems, however, possible that the whole trouble really arises from defective philosophical analysis, and that if the theory of types were suitably modified all need for any such axiom would disappear. But this possibility is not considered by the authors, in spite of the fact that the work of Wittgenstein, for which Mr. Russell has expressed such admiration, appears to point in that direction.

The three new appendices deal with the "Extension of the Theory of Deduction," of which a new account is given based on the work of Sheffer and Nicod, with the new theory of mathematical induction, and with the new and paradoxical philosophical assumption that all functions of propositions are truth-functions, which is defended by various subtle distinctions. We may regret the absence of any reference to the question of identity, or answer to the criticisms of Wittgenstein, "from which," Mr. Russell wrote in his introduction to "Tractatus Logico-Philosophicus," "there seems no escape." A useful addition has been made in the form of an index of definitions.

Although it still achieves no final solution of the difficulties, "Principia Mathematica" is likely to remain for many years the standard work on the subject, and its republication is a most important event.

Oats.

Oats their Varieties and Characteristics; a Practical Handbook for Farmers, Seedsmen, and Students. By Herbert Hunter. (Practical Farming Series.) Pp. 131. (London: Ernest Benn, Ltd., 1924) 8s. 6d. net.

IT is a matter of some significance that this book is addressed to the seedsman equally with the farmer and student, for in the past it has not been sufficiently realised to what a large extent successful crop production is determined by the suitability, genuineness, and quality of the seed employed. The manner in which Mr. Hunter has treated his subject should of itself be

valuable to the seedsman and to the farmer, as showing that the problems of both are in many details essentially the same, and are only to be solved to the mutual advantage of the two interests by painstaking and accurate methods of research.

The origin of the cultivated oat is briefly discussed, and the author does not accept it as definitely proved that the varieties of *Avena Sativa* have originated from the wild oat (*Avena Fatua*), although he would seem to regard the appearance of "false wild oats" amongst the cultivated varieties as an indication of "degeneration" towards the wild type. In this connexion it may be remarked that false wild oats occur equally amongst the oldest varieties like Welsh sprig and the newest like Victory, and in fact probably occur amongst all the cultivated varieties of *Avena Sativa*. The botanical characters of the oat, particularly such as are valuable for discriminating between one variety and another, are adequately dealt with in simple language.

The body of the book is devoted to a description and classification of the chief varieties of oats, and the economic value of each variety is briefly discussed, while in a concluding paragraph the reader is reminded that varieties with a distinctly early ripening habit are not recommended for normally early districts. The descriptions of the varieties have been based on material grown under the author's supervision, and he has used the various characters of panicle, grain, straw, growth habit, and time to reach maturity in a manner very similar to that of Marquand and others, who have also critically studied the varieties of oats.

Distinction is made between *Avena Sativa Orientalis* and *Avena Sativa* proper; the latter is divided into the following five sub-groups, which can be easily and satisfactorily differentiated: "winter hardy," "semi-winter hardy," "potato," "abundance," and "early ripening." Keys are given to the different varieties in relation to the groups and to the varieties of *Avena Sativa Orientalis*. The value of this section of the book would have been enhanced had the author dealt with the question of synonyms, and since in practice the greatest difficulties occur in the recognition of the varieties of the "abundance" division and between some of the newer of the Tartar-like varieties, it is to be hoped that in a subsequent edition of the book such varieties will be described in greater detail.

A comparatively long chapter is devoted to the chemical composition of the oat grain, in which the researches of Brenchley, Brenchley and Hall, Berry and others are faithfully discussed. Although valuable to the student, this chapter is likely to prove wearisome to the seedsman and the farmer. Excellent chapters on seed selection and the production of pure seed conclude the book. The text is supported by eighteen extremely

good figures, which are very typical of the varieties they represent.

No mention is made of the diseases of oats, although the reaction of varieties to disease must at the present time be regarded as one of their most important characters.

Output of Scientific Papers.

Catalogue of Scientific Papers. Compiled by the Royal Society of London. Fourth series (1884-1900). Vol. 19. T-Z. Pp. vi+877. (Cambridge: At the University Press, 1925.) 168s. net.

WITH the publication of the volume before us, the indexing of the scientific papers of the nineteenth century under their authors' names has been successfully brought to a close. It is unnecessary to reiterate the high opinion which we have previously expressed of the practical utility of this monumental undertaking and of the high standard of accuracy maintained by its successive editors and their staffs. The "Catalogue of Scientific Papers" is an indispensable tool for the research student and historian of science alike.

Its value for statistical purposes, however, has not been equally recognised. No statistics were published in the prefaces to the first three Series and their Supplement; but a rough estimate made from a calculation of the average number of entries on a page gives the following results:

Period.	No. of Author Entries.	Yearly Average.
1800-63	195,120	3,097
1864-73	80,070	8,007
1874-83	100,750	10,075
Supplement	26,560	320
1884-1900	384,478	22,616

After 1900 the work of the Royal Society was continued on a greatly extended scale in the International Catalogue of Scientific Literature. Approximate figures of the output of this body were published by the present writer in a work reviewed in NATURE on October 20, 1923, pp. 585-6. The figures are as follows:

Year.	No. of Author Entries.	Year.	No. of Author Entries.
1901 . . .	43,440	1908 . . .	75,034
1902 . . .	49,896	1909 . . .	70,030
1903 . . .	49,264	1910 . . .	85,519
1904 . . .	50,741	1911 . . .	74,773
1905 . . .	73,034	1912 . . .	69,323
1906 . . .	74,877	1913 . . .	62,799
1907 . . .	74,327		

These figures suggest a curious parallelism between the movements in western science and civilisation in the first thirteen years of the twentieth century. Coupling the two sets of statistics it will be seen that the output of scientific papers showed continuous progress from

1800 until 1910—the rate of progress accelerating rapidly between 1884 and 1910—the peak year of scientific activity.

These figures, imperfect as the basis for their compilation admittedly is, deserve the attention of statisticians, and it is to be hoped that in future consolidated author indexes published by the Royal Society, the statistical value of the data contained therein will be kept in view.

E. W. H.

Our Bookshelf.

Living Organisms: an Account of their Origin and Evolution. By Prof. Edwin S. Goodrich. Pp. 200. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 6s. net.

PROF. GOODRICH has written a wholly excellent introduction to biology. The opening chapters deal with the elementary principles of biophysics and biochemistry, and with the nature of life, reproduction and death. The remainder of the book is taken up with an exposition of the facts and theories of evolution, and the author has here given a very clear account of the present state of knowledge of heredity and allied problems, and of the latest advances which have been made in this field, both from the experimental and cytological aspects. The book is intended mainly for the general reader, and the author has therefore been meticulously careful to define exactly the terms which he uses. There can be no doubt at all in the mind of the reader as to what he means by such terms, for example, as inheritance, variation and character. This clarity of meaning is particularly emphasised in his treatment of the vexed question of the inheritance or not of so-called acquired characters. Reiterating the view of Sir Ray Lankester that the characters of organisms are in the nature of responses to environmental stimuli acting on a complex of germinal factors and must be made anew at every generation, he advocates, with the late Prof. Sedgwick, that the popular distinction between acquired and not acquired characters is illusory, and pleads for the abandonment of the expression "acquired" character altogether.

There is much to be said in favour of this view. The true Lamarckian theory of evolution demands the production of changes in the germinal factors of inheritance as the result of environmental stimuli, and of this there is at present no convincing evidence. At the present time, when the Lamarckian position is receiving so much attention at the hands of scientific workers, it is particularly desirable that the general reader should have before him a clear and simple explanation of the situation which will enable him to understand the problem and appreciate the nature of the evidence brought forward for or against the theory. The student of science, too, will find much that is helpful in this excellent little book.

The New Decalogue of Science. By Edward Albert Wiggam. Pp. 287. (London and Toronto: J. M. Dent and Sons, Ltd., n.d.) 7s. 6d. net.

SCIENCE has its natural enemies—it has also its unnatural friends. Nothing could be more distasteful to a genuine student than this hymn to science—a sort

of Main Street Nietzscheanism. The writer assures us that it is "no extravagant assumption, but the surest deduction from science itself, that science only can supply mankind with the true technology of the will of God." This Will is brought down to us in the New Decalogue, written down mainly for the statesman who, we are told, decides "who shall survive and who shall perish in the struggle for existence," who "in a real sense . . . determines the very trend of human evolution." The belief in Divine Will, in science and in statesmanship leads to such views as the following: "that the advanced races are going backward," "that medicine, hygiene and sanitation will weaken the human race," "that morals, education, art and religion will not improve the human race"—all these are chapter headings.

We are ready to admit that "pauperism is as distinctly inherited as the capacity to create wealth" or perhaps even more so. But the author's proof sounds like insufficient induction: "I know one family in which in a hundred and fifty years not a single member has saved up five hundred dollars." We are at first shocked to hear that "Vice and disease purify a race. Wickedness, folly, sin, are all nature's methods of racial purification." But we acquiesce when we are told that "the old Hebrew statesmen saw this principle of nature as clear as day. They constantly said in substance: 'The children of the wicked are cut off,' 'The fool shall perish by his own folly,' . . . 'The wages of sin is death.'" All this apparently shows that modern biology could be taught from the Old Testament.

The worst of it is that the book, written in a thoroughly unscientific spirit, yet advocates many good things such as eugenics, biometric research, application of biological conclusions to sociology and politics—all of which are bound to suffer from such advocacy. No wonder that a professional, though not very dangerous, enemy of science, Mr. Bernard Shaw, has easy play with the book in a letter which the author has proudly appended to the volume. It is both unpleasant and difficult to safeguard the interests of science from such benevolent and enthusiastic propaganda of its self-appointed apostles.

B. M.

Adventures of Exploration. By Sir John Scott Keltie and Samuel Carter Gilmour. Book 1: Finding the Continents. Pp. iv+128+4 plates. 1s. 6d. Book 2: Central and South America. Pp. iv+156+4 plates. 1s. 8d. Book 3: Asia. Pp. iv+164. 1s. 10d. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd., n.d.)

"TRAVAILLE," said Bacon, "is a Part of Education. . . . Let Diaries, therefore, be brought in use." The authors of these books on adventures of exploration have ransacked the diaries of the world's greatest travellers to describe in simple language some of the outstanding expeditions by which the world has been discovered by and for Europeans. The stories range in "Finding the Continents" from the epoch-marking voyages of Columbus to those of Barents and Cook in the northern and southern seas. South America forms the scene of exploits from Cortes in Mexico and Pizarro in Peru to Fitzgerald's magnificent failure on the height of Aconcagua and Roosevelt's voyage on the River of Doubt. In Asia, between the romantic

journeys of Marco Polo and the tragic struggles to conquer Everest, there are a dozen stories of adventure and daring, not merely to lay bare the secrets of Nature, but to inquire into the habits and the life of man. De Lesseps in Siberia, Manning at Lhasa, Layard in Persia, Garnier on the Mekong, Burnaby at Khiva, and Doughty in Arabia, these are some of the adventurous travels sketched lightly and interestingly in this book. Useful sketch maps, recalling in their style and ornament the old maps of travel, make the narratives of special value and justify the authors' hope that these "supplementary readers" will quicken interest in geography by stories of adventurous travel. The selection has been well made, and the narratives not only afford an idea of some of the main steps by which knowledge has been gained, both of the world as a whole and of the separate continents other than Europe, but show also how many place names owe their origin to explorers, and recall incidents of exploration.

A Brief History of Civilization. By John S. Hoyland. Pp. 288. (London: Oxford University Press, 1925.) 3s. 6d. net.

WE ought to welcome the efforts, which are now becoming so frequent, to present the history of mankind as one, a progressive thing, culminating in a unity of which the League of Nations is the symbol and organ. Mr. Hoyland's little book is the best we have seen at the size and price, and it is published by the Oxford Press, which is distinguishing itself for works tending in that direction. Kant's prediction of the course of history-writing, made in 1782, is beginning to be realised in our day; that part and type of history is being most studied and commemorated which tends to the general good of mankind. Mr. Hoyland is possessed by this idea, and consequently gives us an appreciative account of China and a full, though discriminating, judgment of the contributions of Greece and Rome. There is also more, though not so adequate, allusion to the rôle of science in history than would be found in most books of earlier date.

The less effective part of the book is the last third, where the facts are so multitudinous as to occasion more compression and generalisation, and we think the general treatment suffers by the emphasis on the evils of nationalism and the discussion of problems raised by the growth of internationalism. It is really better, from the author's own point of view, to describe sympathetically what the various nations have done towards the common end than to dilate on the underlying problem. In practice this means more space *all through* to the triumphs of science, invention, and various forms of international association, rather than relegating all these topics together to one concluding chapter. But the book on the whole is sound and useful, and a great advance on anything of the kind yet attempted, and it is admirably illustrated and produced.

F. S. MARVIN.

Essentials of Scientific Method. By Prof. A. Wolf. Pp. 160. (London: G. Allen and Unwin, Ltd., 1925.) 5s. 6d. net.

PROF. WOLF'S delightful book should be in the hands of every teacher of science. It is written with an admirable lucidity, and treats its subject in such a plain and

straightforward way that no previous knowledge of logic or psychology is necessary for its comprehension. Most science teachers are interested in the philosophy of scientific method, but comparatively few have the leisure to make a thorough study of it. To the busy majority Dr. Wolf's book will prove of great interest and value, and for the others it will provide a convenient epitome.

The author does not go deeply into the fundamental question whether the world which science describes is a world of reality, and in this he is wise. He confines himself to a description of the methods actually employed by science to obtain those results which are familiar to every one. His treatment of "Order in Nature and Laws of Nature" is a particularly skilful exhibition of skating upon thin ice, but there can be little criticism of the position he adopts. "On the whole," he says, "experience has shown that there is some order in nature, even if nature be not orderly through and through." We cannot agree with him, however, when he says (p. 126) that it is not very likely that Boyle's Law and similar generalisations would be assumed to hold good of newly discovered substances without experimental verification. E. J. H.

La matière vivante: organisations et différenciations, origines de la vie, colloïdes et mitochondries. Par Prof. J. Kunstler et F. Prévost. Pp. 253. (Paris: Masson et Cie, 1924.) 18 francs.

THIS rather curious booklet contains an exposition of the authors' views on the structure of protoplasm. Their main contention is that the structural organisation of protoplasm is as important for the processes of life as is its chemical composition. With this few would disagree, especially after the remarkable experiments of Warburg and others upon the rôle of structure in such fundamental activities as respiration.

The book, however, is uncritical and one-sided. All sorts of structures are lumped together, and the work of others is very unequally treated. Little attention is paid to the views of such authorities as E. B. Wilson, R. Chambers, and others, that the visible structure of protoplasm may readily change in accordance with change of physiological state, nor is there any proper discussion of modern work on micro-dissection or physiological cytology.

The work will be of some interest to the specialist, but can scarcely be recommended to the general biological reader.

The Annual Register: a Review of Public Events at Home and Abroad for the Year 1924. Edited by Dr. M. Epstein. (New Series.) Pp. xv+326+171. (London: Longmans, Green and Co., 1925.) 30s. net.

THIS admirable survey of the year's history is planned on the lines which have been long familiar. An account of British history, followed by foreign and imperial history arranged under the headings of the various states, occupies two-thirds of the volume. Then come a tabular chronology of events, a survey of literature, art, music, science, law and finance, and obituary notices of the year. These surveys are necessarily very condensed, but lack neither lucidity nor critical estimates of the field of survey. Some of the more important treaties and agreements of the year are printed in full.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Ether-Drift and Relativity.

DR. SILBERSTEIN'S deductions from Prof D C Miller's surprising optical experiments, as contained in NATURE for May 23, are equivalent to stating that there is a drift of the ether with respect to the earth, and the horizontal component velocity of this drift is very small at ordinary ground level but rapidly increases with height z , so that it reaches about 10 km./sec at the height of Mt. Wilson (1.731 km), whence $\partial u/\partial z = 5.7 \text{ sec}^{-1}$ approximately for the intermediate zone. The mere existence of this measurable drift would be in conflict with the very foundations of relativity.

Objection against these conclusions is raised in NATURE for June 6 by Prof. Eddington, who remarks that the described ether-flow being strongly rotational, it could not satisfy Stokes's condition for non-influence on astronomical aberration; and the consequences would be in disagreement with the measurements made every day in astronomical observatories.

I think that from the mathematical point of view this objection may be removed on remarking that it takes into account only the horizontal component of the drift. If x is the co-ordinate in the direction of this component, and w is the vertical component of the drift, the full expression for the curl of the drift-velocity in the xz plane is $\partial u/\partial z - \partial w/\partial x$, and therefore the flow might be everywhere irrotational, even with a high value of the term $\partial u/\partial z$, provided there is a corresponding $\partial w/\partial x$ to match it.

It is true that in the light of the first theory given by Stokes and expressed by Lorentz in his standard book "The Theory of Electrons," Ch. v, 147-148, the irrotationality of the flow would not be sufficient to destroy the influence on aberration, and certain additional conditions ought to be satisfied by the velocities of the ether near the stars and near the earth. But a careful consideration shows that the aberrational effects as observed by astronomers do not depend on the differences between the directions on the wave normals at the origin and the end of the light-ray, as considered in the above theory, but exclusively on the paths of the light-rays themselves. Therefore, the right theory to be employed is the second one given by Stokes with Challis's corrections, and further developed by Larmor in "Aether and Matter," III 22, according to which the irrotationality is the only condition required.

In the light of this conclusion, Planck-Silberstein's hypothesis of an irrotational and extremely compressible ether with a negligible drift at ground level might be sufficient to secure agreement with all standard astronomical measurements at all heights, and with terrestrial geodesic observations (absence of geodesic aberrations); but it requires a compression so high as 60,000 at sea-level, and it further requires that the "grip" of the earth on the ether be purely gravitational, according to Silberstein's vivid expression, because Michelson and Gale's experiment has shown that the ether does not follow the daily rotation of the earth. Even a broader theory might be adopted, since the latter experiment, performed inside an iron pipe, shows that the pushing forward of the ether by the earth, if any, is not due to impenetrability or to adhesion to material surface, and

therefore Planck's condition that the vertical flow of the ether at ground level be zero may be discarded.

Three points of difficulty are, however, to be considered, namely:

(1) To show that an irrotational distribution of flow can be effectively mapped out, which numerically agrees with the various values of the horizontal velocity found by Prof Miller at different heights and times.

(2) To explain why, since the grip on the ether is not due to material surface adherence, its horizontal drift is reduced so nicely to zero at about sea-level and not to any other level whatever.

(3) Since $\partial w/\partial x$ requires to be so high as 5 or 6 sec^{-1} , it follows that if the vertical drift be zero at a certain point, it will be about 500 km./sec. at some point at 100 km. distance at the same level. If there is a vertical ether flow of this magnitude, it will be revealed at once by very common electromagnetic experiments or by a quite unrefined repetition of Prof. Miller's experiment in a vertical direction.

In the present condition of things it will be advisable not to draw any conclusion from Prof. Miller's experiments until results of further experiments are available, and until, finally, we are able to examine whether some unknown phenomenon has affected the results.

GIOVANNI GIORGI.

University of Rome

(Regia Scuola d'Ingegneria),

June 29.

P.S.—Since writing the above, I have seen Prof. Miller's article which appears in the issue of NATURE for July 11, giving further and very interesting particulars on his experiments. My conclusions are not modified by it.

G. G.

Experimental Study of the "Soaring" of Albatrosses.

THE letter by M. Idrac, under the above title, in NATURE of April 11, was one constituting an earnestly important contribution to the fascinating subject of soaring flight; for it is undoubtedly the case, that so far as the sea considerably impedes the lower strata of the wind, an albatross must be able to soar in the manner recorded. The methods of energetics (having regard to the internal energy of the air) may certainly be employed to indicate this, but the less often used acceleration-of-headway method may be employed as a simple, precise, kinematical alternative. For example, when the bird in its relationship to the enveloping air is gliding upwards at an angle α degrees above the horizontal, at a headway of V feet per second, and against a wind from the north, it is tending to lose headway gravitationally at the rate of $g \sin \alpha$ feet per second per second. It may also be regarded as tending to lose headway frictionally, at the rate of g/n feet per second per second, where n is the ordinary lift/drag ratio. On the other hand, if the higher strata of the wind are travelling faster southwards, to the extent of v feet per second for each foot of vertical height, the bird tends to gain headway at the rate of $V'v \sin \alpha \cos \alpha$ feet per second per second, because $v \cos \alpha$ feet per second is the component of increment of wind velocity head on to the bird, per foot change of height, and $V' \sin \alpha$ feet per second is the vertical rate of gain of height. Accordingly, for the bird to continue gliding upwards at steady or increasing headway it simply needs to have

$$V'v \sin \alpha \cos \alpha - g \sin \alpha - g/n < 0, \quad (1)$$

that is to say, not negative.

From (1) is deducible for calculation,

$$v \propto \frac{g}{V} \left(\sec \alpha + \frac{2}{n} \operatorname{cosec} 2\alpha \right). \quad (2)$$

For every angle α at which the bird may choose to steer upwards there is therefore a certain v of the air which will keep the bird gliding without losing headway; but the particular angle α that allows v to have its minimum serviceable value, and in which therefore we are most interested, is ascertainable from (1) or (2) to be governed by the condition that

$$(2 \operatorname{cosec} \alpha) / (\sec 2\alpha - 1) = n, \quad (3)$$

quite independently of what the V of the bird may be.

For the following values of n —

0, 1, 5, 10, 15, 20, 30, 50, ∞ ,

formula (3) determines these corresponding approximate values of α ,

45°, 38°, 28°, 24°, 21°, 20°, 17°, 15°, 0°,

or about twenty degrees for the whole range of values of n usually found in practice. In particular, the birds with $n=18$, observed by M. Idrac, have the comparatively steep angle of 20·4 degrees as the best angle α up which they should prefer to steer in this kind of soaring. Inserting therefore this value of α in formula (2), and also inserting the observed value of 72 feet per second for the value of V , it transpires that those birds may soar steadily upwards against the wind when v , the increment of wind velocity per foot of height, is not less than 0·552 feet per second. If v exceeds this the bird will not merely not lose headway, but actually be able to gain headway, even for a range of upward angles α a little greater and a little less than the best angle of 20·4 degrees of this case. This width of range of angles, less than and greater than the best, increases when v is increased, according to values deducible from formula (1) or formula (2).

It is notable that in formula (2), v is inversely proportional to V , quite confirming the observations made, that the birds of greater headway more easily perform this kind of soaring; but at very great headways and for the whole soaring manoeuvre this rule tends to reverse, when the energy-wasting reactions of sharp turns, up and down as well as sideways, with large birds and especially with large aeroplane appliances, are taken into account. As regards rules, this seems the place to recall that the best angle of ascent has no connexion with V but only with n , and that the best angle of ascent is not very sensitive to ordinary differences in even n , nearly always wanting to be about twenty degrees—a simple rule for bird or man.

For the return or southward journey we may use the same expression (1), but with the sign of the gravitational middle term made positive, and with the angle α measured downwards from the horizontal; and we can insert the minimum value of v just found and supposed to be prevailing, that is, 0·552 feet per second. The angle α so determined for a steady glide for the bird of headway 72 feet per second is then a mere 1·4 degrees downwards from the horizontal. Truly it is downwards and not upwards, but as it is only about half the ordinary gliding angle, the bird evidently obtains some soaring assistance even on the return journey.

The whole indicated procedure of the bird, then, as viewed from the east, and entirely corresponding to observations made, is to glide to the right and steeply upwards from the surface of the sea, until it reaches the height where v ceases to be so great as 0·552 feet per second. If this height is 100 feet, the bird takes $100/(72 \sin 20\cdot4^\circ)$, or about 4·0 seconds to arrive. There the bird wheels round and takes a

long flat glide to the left, of duration $100/(72 \sin 1\cdot4^\circ)$, or 56 seconds, down to the surface of the sea, where it again wheels round and proceeds to repeat the whole cyclic process every 60 seconds. But it is to be noticed that each brief ascent of the bird takes place much farther down-wind than the last ascent, so that the bird may drift rapidly southward through the seascape; even nearly as rapidly as the headway of the bird plus the velocity of the wind at a height of about 50 feet, and that may easily be so great a total as 60 to 70 miles an hour. It becomes, therefore, a debatable point to consider how much or how little the bird may depend on this particular cycle of soaring, and yet preserve its position in the seascape, outside a headland or bay or close to a slow ship, so well as it sometimes does.

But the fact which just for an instant can occasion a little surprise, is that the bird need not turn round, but may continue northward against the wind. It may not soar higher, and it cannot even continue to glide level without losing headway, but it may, and indeed must direct itself steeply downwards to proceed at steady headway. The negative value of α that satisfies formula (1) is 42 degrees, and at that slope the bird may descend 100 feet in $100/(72 \sin 42^\circ)$, or 2·1 seconds, after previously taking the 4·0 seconds to ascend at the slope of 20·4 degrees. The procedure of the bird is now to execute a series of deep hollow swoops, northwards against the wind, pointing down at 42 degrees for 2·1 seconds and then up at 20·4 degrees for 4·0 seconds, the whole swoop being then repeated every 6·1 seconds. The progress northwards is at the rate of $(2\cdot1 \times 72 \cos 42^\circ + 4\cdot0 \times 72 \cos 20\cdot4^\circ)/6\cdot1$, or 62·5 feet per second, or 43 miles an hour relatively to the air at the mean 50-foot level, so that to the extent that the wind at the 50-foot level is less than 43 miles an hour the bird can actually advance northwards through the seascape, against the wind. When it has so progressed for a mile or so in a number of swoops, then it may wheel round and take the pleasant, long flat glide with the wind, and continually repeat such a grand combination process in a way to keep to one locality in the seascape.

Nevertheless, the above presents the case as a pure case, artificially arranged so, and of necessity, for the purposes of calculation and abstract reasoning. The strata of the actual wind must refuse to shear smoothly over one another without breaking into a turbulent state, and especially into small and large eddies rotating around horizontal cross-wind axes. These turbulences offer other opportunities of soaring, that are also to be expounded in the form of pure, abstract cases, and so great an artist as the albatross may not be wholly negligent of, and unthankful for, such opportunities, although *stratified structure-gust soaring* (if that name be allowed) may be the bird's great favourite. The name "stratified structure-gust soaring" may be understood to refer to the fact of the wind being supposed to be stratified in its velocity structure, and also to the fact of the bird soaring by a head gust that is present, not as an actual acceleration of the air particles themselves, but by reason of the bird judiciously crossing the velocity structure of the air in such manner as to develop for itself a useful "structure-gust" effect. This term was similarly proposed in 1913, in the book "Aeroplanes in Gusts and Soaring Flight," by the present writer.

Now, so far as an albatross can soar in the way observed and described, there would seem little reason why a small and fast aeroplane, manned by an interested pilot, should not immediately soar to some extent in a like manner, by facing the wind blowing

over the sea or a large lake, or possibly over a large flat plain, and quickly swooping down and up close to the surface—pointing down at about 40 degrees and then up at about 20 degrees, or at about half these angles if the propeller is allowed to be of some assistance. At suitable intervals it may take the long flat glide with the wind. In any case, however, independently of soaring, aviators may have need to consider that in starting off against the wind it may be convenient to point up at an angle approaching 20 degrees, and so endeavour to continue; and in the event of being compelled to point their aeroplanes down they may have need to be prepared for the lowest strata of the air near the sea seeming to refuse proper support. Indeed, some experiences of this character already seem to confirm M. Idrac's observations of the wind near the surface of the sea.

S. L. WALKDEN.

London, June 8.

Science and Intellectual Freedom.

It is with considerable amusement that I have read the collection of opinions published in *NATURE* upon the recent action of the State of Tennessee in forbidding the teaching of what we believe to be the established facts of human evolution in schools supported by public funds. There is an admirable undertone of contempt and condemnation in most of these contributions and a scorn that spreads at moments from Tennessee and Oklahoma to things American in general. Yet the British Government is at the present time in an almost parallel position to the Government of the benighted State of Tennessee in regard to a closely similar body of knowledge. At present if a medical officer of health or a health visitor in public employment gives information about contraceptives to a patient publicly paid for, he or she is liable to dismissal, and several cases of dismissal have occurred. The Minister of Health in both the previous and the present governments has refused to allow these officials the freedom, at their discretion and with all circumstances of privacy, to give this sort of information to adults asking for it from them. There is no question of propaganda here or of forcing this kind of knowledge upon those unwilling to receive it. But British adults of the poorer classes wishing to know this much about their own bodies and to have this much of control over them, cannot get it in a private, seemly and proper manner from their publicly supplied and duly qualified medical advisers, but must resort to the one or two over-worked privately supported clinics that exist, or to furtive expedients, to quacks and underhand and dubious sources of information. This is mainly a concession made by these successive Ministers of Health to the Roman Catholic vote. They plead that taxpayers of that persuasion might object to their money going to supply such knowledge to people with different views. But that is precisely the argument of the Tennessee legislators. They plead that a respectable body of old-fashioned Christians regard the doctrine of human evolution as a dangerous and sinful heresy and that therefore they may object quite reasonably to their money being spent upon its diffusion.

In all these matters I am for open and accessible knowledge and free and frank discussion everywhere, in Britain as in Tennessee, but I submit that the *élite* of British science have no case against the State of Tennessee until they have done something to put our own house in order. Perhaps later you will give us another Supplement of a rather wider scope and raise the whole problem of intellectual

freedom in relation to these modern publicly endowed systems of education in which the teacher is at any time liable to the irruptions and direction of the government and the politician. The bulk of our educational organisation at every stage and much of current research could not exist without State support and subsidies, and the riddle of receiving maintenance without sacrificing freedom is a very fine and subtle one, which is not disposed of by damning Tennessee.

H. G. WELLS.

Easton Glebe, Dunmow,
Essex, July 16.

On the Presence of a Perennial Mycelium in *Pseudoperonospora Humuli* (Miyabe & Takah.) Wils.

IN a recently published article (*Annals of Applied Biology*, 12, p. 121, 1925) we have given a description of the downy mildew of the hop (*Pseudoperonospora Humuli*), a disease until recently unknown in England or in Europe, but now beginning to cause considerable damage in Kentish hop-gardens. The object of this note is to record certain new facts, of scientific and economic importance, which have been lately discovered in the life-history of this fungus.

The occurrence of diseased, stunted, "spike"-like shoots arising from the root-stock of the hop so early as April led to a search being made for mycelium in the perennial underground parts. Examining during May one- and two-year-old diseased nursery "sets," by means of hand-sections stained with azo-blue, the existence of mycelium was ascertained in the pith and cortex of one-year-old portions of the "crown." The mycelium was not traced lower than this, but there is a possibility that it may be even deeper-seated. The presence of a hibernating mycelium in certain members of the Peronosporaceæ has already been recorded; in the case of the beet mildew (*Peronospora Schachtii*), by Kuhn, in 1873; and in the onion mildew (*P. Schleideni*), by Dr. P. A. Murphy, in 1921 (*NATURE*, 108, Nov. 3, p. 304).

The alarming feature of the outbreaks of the hop downy mildew which are now taking place for the first time in hop-gardens in England is their epidemic nature and the early attack on the young stems ("bines"). Under the influence of the disease the tips of normal, healthy-looking bines, when these are 5-7 feet high, are suddenly arrested and transformed into a tufted or "spike"-like growth. As many as seventy per cent. of the hop-plants ("hills") in a garden may show the disease, and in some cases all the stems ("bines") trained up may prove to be diseased. While in the case of the shorter basal "spikes" the mycelium appears to be continuous throughout their length, this is not necessarily the case with the longer diseased bines, where the mycelium may be absent from certain nodes, with the result that healthy lateral shoots may be produced. Within the stunted "spike" of the longer stems the mycelium is present close behind the growing point of the apical bud and extends along pith and cortex commonly for a foot or more. The extent of the mycelium within the pith is marked by a brown discoloration; in internodes where the pith is hollow the fungus has been found to accumulate hyphæ which form a lining for the hollow cylinder. These hyphæ give rise to oogonia and antheridia, and the pith eventually becomes lined with masses of oospores. These oospores, which hitherto have been reported as occurring only in the leaves, have been found in abundance within stems so early as mid-June, and in one case in May. The occurrence of oospores in "spikes" renders imperative the destruction of the latter, when they have been removed by the grower.

In several cases it has been found that the mycelium in the cortex penetrates the epidermis and produces masses of conidiophores on the outside of the stem, which is rougher and coloured light-brown in those areas.

On rare occasions a few conidiophores with conidia are found projecting into the pith cavity, in regions where formation of oospores is taking place.

E. S. SALMON.

W. M. WARE.

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Seed Dissemination of Nematoda.

RECENT American workers have directed attention to the fact that Nematoda attacking certain plants are regularly disseminated in the seeds of their host.

Whilst working on the relation of *Tylenchus dipsaci* Kühn to one of its common host plants, namely, the oat, the occurrence of various Nematoda between the pales was observed. Some correlation between such occurrence and a relatively poor development of the plant was also observed. Various genera were identified, notably *Tylenchus* and *Diplogaster*, but the forms most commonly present were small larvae so immature that accurate identification was not possible.

Seeds known to be so infected and germinated under sterile conditions were, on later examination, found to harbour numbers of Nematoda of a species of the genus *Cephalobus*. It seems, therefore, that dissemination in seed must be accepted as one at least of the normal methods of spread of the species in question. Special interest attaches to this, for so long ago as 1906 Marcinowski showed that *Cephalobus elongatus* Sch. was capable of injury to cereals, while Steiner has recently shown that the species *C. subelongatus* Cobb. may cause damage to the foliage of Phlox plants.

W. E. H. HODSON.

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Observed Stark Effect Patterns in Helium.

RECENTLY I have taken photographs of the Stark effect in helium which show quite clearly that the parhelium principal series line $\lambda 3965$ has the pattern $1/1$ (i.e. one component plane polarised parallel to the field, and one component circularly polarised perpendicular to the field) instead of the complex pattern $3/3$ reported by T. Takamine and N. Kokubu (Mem. Coll. Sci., Kyoto, 3, 275, 1919). With improved experimental conditions, the new spectrograms prove that the simple displacements ($1/1$) reported by Stark and Nyquist for the members of the sharp and principal series are correct, and that the complex analyses claimed for some of these lines by Takamine and Kokubu were due to insufficient control over the Lo Surdo tube.

A further point of interest is the appearance of a new weak perpendicular component of the parhelium combination line $\lambda 4384$. In a field of 40 kv./cm. this line has two components with wave numbers 22832.8 and 22839.0. This completes the pattern $2/2$ for all members of the combination series $2P - mP$, $m = 4$ to 7 inclusive.

Two examples of the pattern $2/3$ have been brought to light in this investigation. (1) The parhelium diffuse series line $\lambda 4922$, in an electric field of 45 kv./cm., is found to have components with the following wave numbers:

par. 20293.9, 20295.8
perp. 20293.9, 20295.8, 20302.3; densities $4, 5, 1, 2, 7$.

(2) The accompanying photograph (Fig. 1) shows two orthohelium lines in electric fields. As usual, a double image prism has been used to separate the parallel (upper) and perpendicular components. At the top of the photograph there appears to be but one line—the diffuse series doublet $\lambda 4472$. Since this is not resolved, the analysis shown here is assumed to be that of the stronger component. In high fields, near the cathode, this line is deflected toward the left and split into two components. A very faint line in the normal undispersed position is due to stray light not emitted by the main source. It is useful as a line of reference. Immediately at the right may be seen the combination line $2p_1 - 4b$ making its appearance in a very low field (Harry Nyquist, *Phys. Rev.*, 10, 226, 1917). This line has the pattern $2/3$. Most of the components are over-exposed in order to show the new perpendicular component. The insert is a photograph of the perpendicular component of He $\lambda 3965$ in fields up to about 50 kv./cm.

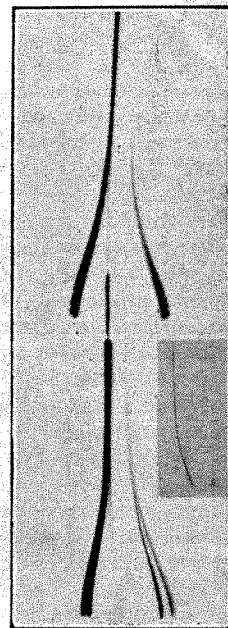


FIG. 1.—Orthohelium group $\lambda 4472$ in electric field, and, on right, perpendicular component of He $\lambda 3965$.

These patterns for helium series lines are identical with those claimed for the corresponding hydrogen fine structure components in the theory given by H. A. Kramers (*Zs. f. Phys.*, 3, 199, 1920).

J. STUART FOSTER.

McGill University, Montreal, Canada,
June 15.

The Word "Australopithecus" and Others.

WHEN Dr. Bather hints (*NATURE*, June 20, p. 947) that the word "Homosimiidae" is not correctly compounded, he probably means that the compounding stem of *homo* is *homi-*, as in the Latin *homicida*. But "Australopithecus" is also incorrectly formed, for the compounding stem of *australis* is *australi-*.

Why will people venture to invent new names without consulting an etymologist? Neglecting this precaution, even a good classical scholar may flounder.

F. J. ALLEN.

8 Halifax Rd., Cambridge,
June 28.

Cancer Research.

REFERRING to the recent work on cancer by Dr. W. E. Gye, the statement in *NATURE* of July 18, p. 107, that Dr. Gye was "assisted by Mr. J. E. Barnard and Dr. J. A. Murray," which has also appeared elsewhere, attributing to me a direct participation in the work of Dr. Gye and Mr. Barnard, requires correction.

The very generous acknowledgment in Dr. Gye's paper in the *Lancet* sums up all my association with his researches. I should be lacking in candour if I permitted the suggestion of a closer collaboration to pass without a disclaimer.

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The Natural Classification of Ferns as a Study in Evolutionary Methods.¹

By Prof. F. O. BOWER, F.R.S.

IN the light of evolutionary theory the object of a natural classification of living things has ceased to be a mere catalogue, useful primarily for the recognition and accurate designation of genera and species. Such a classification is now understood to express, at least in some degree, the evolutionary relations of the organisms classified, though still it may be far from fulfilling its theoretical end. Kin will take place near to kin, and if the relationships be truly apprehended, the whole grouping of different forms will be such as to seriate them, so that those earlier in historical origin should precede those of later appearance. The series would lead from presumably primitive to presumably derivative types. But naturally a simple linear series, such as any catalogue must show, cannot adequately portray the highly complex relations of any well-represented group. Moreover, such relations are apt to be so obscured by the extinction of intermediate forms that, though this might at first sight appear to simplify the problem, it at the same time increases greatly the difficulty in recognising affinities, and often makes any definite opinion on relationship highly problematical.

In the face of such drawbacks many are disposed to regard the problem of natural classification as hopeless: and the results attained may appear to be mere expressions of personal bias. Moreover, the divergences of opinion expressed by different experts in the investigation of the same group are sometimes so great as to forfeit confidence in their methods. The critic may then conclude that the materials available for inductive argument are too disconnected, and positive data too deficient to lead to any satisfactory result. However true this may actually be, the demand may still be made that at least the classification adopted for any given group shall not violate, but rather accord with such settled conclusions of affinity as are founded upon an adequate field of observation comparatively treated. The wider the area of observation the more probable will it become that the grouping based upon it will be correct. This is indeed the theoretical basis of any classification that can be regarded as natural.

Many groups of plants, comprising at the present day numerous genera and species, appear so highly standardised as to give little scope for such treatment. The differences that they show are relatively minute, while in the absence of a consecutive geological record of their past history it may appear impossible to rank those differences in any probable phyletic sequence. This is the condition of the Angiosperms as a whole: consequently little headway has yet been made in their phyletic grouping: while opinions are by no means in full accord as to what characters are to be held for them as primitive, or as derivative. But it is otherwise with the Filicales. There are many thousand species of living ferns, distributed in more than a hundred well-marked genera. The range of variable characters which may serve for their comparison is wide: while the class is represented with a more or

less consecutive history back to the Palæozoic age. These facts at once suggest that the class of ferns would provide material suitable for a searching experiment in the methods upon which a natural classification may be based.

We have seen that in order to obtain a stable result it is desirable to extend the comparison over a wide area of fact. The weakness of early groupings for the ferns has been that the area of comparison was too narrow. It involved chiefly the external form, and the sorus and sporangia, while anatomy and the characters of the gametophyte were scarcely used at all; nor was the palæontological evidence taken into account. Though naturally the features of the sporophyte, being more elaborate and also more varied, still take the prior place, all variable features should be used. In respect of each the limits of variability must be defined and the question considered whether one extreme or the other should be regarded as primitive. Here a comparison with related fossils becomes important, and often indeed it is decisive, as in the conclusion that the Eusporangiate type is more primitive than the Leptosporangiate.

There are already twelve criteria of phyletic comparison in use in ferns, and others may probably emerge later. They are: (1) external form of the shoot; (2) architecture and venation of the leaf; (3) initial constitution as shown by apical segmentation; (4) the vascular system; (5) dermal appendages; (6) position and structure of the sorus; (7) indusial protections; (8) character of the sporangium; (9) spore-output; (10) morphology of the prothallus; (11) the position and structure of the sex-organs; (12) embryology. In respect of all of these, but naturally in varying degree, it is possible to distinguish a type that is held to be relatively primitive, from that which is derivative. Moreover, so far as comparison with related fossils is possible, the palæontological sequence may be taken as a check upon conclusions, since its data are drawn from the most positive source that is available in comparative morphology. Further, it is found in the Filicales that the results of comparison, thus checked, run substantially parallel in respect of the several criteria upon which the comparisons are based. Exceptions do as a matter of fact occur; but the marked preponderance of parallel progression in respect of features so dissimilar as, for example, sporangia and antheridia, dermal appendages, conducting tissue, and spore-output, gives added confidence to the application of a comparative method so broadly based and so adequately checked.

From materials such as these it has been possible to draw up a verbal specification of a type which would embody all the relatively primitive features, and thus it might be visualised as a common archetype, which should represent something like that source from which we may presume that the class of ferns may ultimately have sprung. The specification would comprise an upright radial shoot, perhaps rootless, and forking equally if it branched at all; the distinction of axis and leaf ill-defined; the leaf, if recognisable as such, long

¹ Substance of three lectures delivered at the Royal Institution, May 27, 28, and June 4.

stalked, forking, with its segments narrow, and separate one from another; the general cellular construction robust, and without a single initial cell in the several parts; the conducting system consisting of simple tracts with solid xylem-core; the surface bare, or with simple hairs; the sporangia solitary, distal, and relatively large; the spores numerous in each sporangium, and all alike; and the opening mechanisms of the sporangia not highly organised. Naturally, since the prothalli are not as a rule preserved as fossils, little help is derived in checking the comparisons of the gametophyte; and it is omitted in the specification, which applies only to the sporophyte.

If the above specification be compared with the actual features displayed by the fossils of the Rhynie Chert, so beautifully revealed by Dr. Kidston and Prof. Lang, it will be seen that a substantial similarity exists. It is not suggested that any one of the Rhynie fossils itself represents an ancestor of the ferns. What does appear is that, among the vegetation of the earliest adequately known land flora, there existed plants which shared those leading features of the sporophyte which wide comparison of the ferns, living and fossil, has led us to regard as primitive for them.

Starting from such a source, which is not, as a matter of fact, far removed from what is actually seen in the extinct Botryopteridæ, a general advance may be traced through the ages, culminating in the modern Leptosporangiate ferns. The leading features of progression consist in departure from the upright habit, and equal dichotomous branching of axis and leaf; progressive webbing of the leaf-segments and adoption of netted venation; elaboration and progressive disintegration of the conducting tracts; substitution of flattened scales for simple hairs; transit of sori from distal or marginal to superficial positions; passage from the simple sorus with simultaneous sporangia, to a gradate or a mixed succession of them; elaboration but often also a final abortion of indusial coverings; progressive diminution of the individual sporangium, with corresponding increase of their numbers, and of the precision of their ejaculating mechanisms; finally, a diminution of the spore-output from each, from many thousands to definite numbers such as 64, 48, 32, 16, 8, or even in extreme cases to a single one. These progressions run substantially parallel, and accompany a progressive fining down of structure from the grosser Eusporangiate to the more delicate Leptosporangiate type.

Such evolutionary progression, traced by wide comparison in respect of many criteria, and checked by reference to the palæontological record, which in the ferns is both ample and consecutive, may be expected to yield material for argument as to the methods of evolution. In particular it makes possible views involving the essential factor of geological time, so often omitted or wholly forgotten in the evolutionary discussions of the moment. Between the Devonian period and the present day there is spread out before us the whole drama of fern-evolution, including the changes profusely polyphyletic, embodied in the previous paragraph. We may fix our attention especially upon two marked features upon which the series throws light, namely, the slide of the sorus from the margin to the surface of the widening leaf, and the progressive

elaboration of the vascular tissue with increasing size of the part it traverses. Evidence of progress in respect of both of these may be traced not only in the race, where the results are found to be hereditarily fixed, but also in some degree in the individual life, where they are seen to be still plastic.

The shifting of the sorus from the margin to the surface of the expanded leaf gives the biological advantage of protection from direct insolation during development. In some families, such as the Marattiaceæ, Gleicheniaceæ, and Cyatheaceæ, and in Todea, it happened early in geological history, and became hereditarily fixed with a high degree of uniformity. In others, as in the Schizæaceæ, Hymenophyllaceæ, and Dicksoniaceæ and in *Osmunda*, the primitive marginal position was retained. In some the transition from a marginal to a superficial position may be seen actually in progress, as in the *Dennstædtiineæ* and *Pteridaceæ*. The transition may be held as adaptive, and the steps of the adaptation may actually be followed in the individual development in such genera as *Dennstædtia* or in *Pteridium*. Such facts, the details of which will be found fully described elsewhere,¹ suggest that a widespread and polyphyletic phenomenon of adaptation is before us. It may be described as a slide of the sorus from the margin to the lower surface, which is clearly a biological adaptation. The genera quoted show that it is actually progressive in the individual development. The evidence suggests very strongly that there has been a widespread inheritance of a character primarily acquired by biological adaptation in the individual, and that it has become fixed as a heritable character not once only but repeatedly. The whole period of geological time from the Devonian onwards has been available for the process, which has happened in some phyla early, in others late, and is in some individual living ferns caught actually in the plastic or nascent state.

A similar argument may be advanced in relation to the progressive expansion and disintegration of the conducting tracts in ferns, which appears to be closely connected with the limiting factor of size, and the adjustment of the proportion of surface to bulk in an enlarging organism. The progressive expansion, elaboration, and even disintegration may be traced in perfection in the ontogeny of such ferns as *Gleichenia pectinata*, *Pteris podophylla*, or *Plagiogyria*. The elaborated result has become hereditarily fixed with characteristic differences in detail in many distinct races of ferns. The resulting structure provides features sufficiently stable to serve for far-reaching comparison.

Such arguments and such conclusions will of course be met by the objection that they traverse the doctrine of the non-inheritance of acquired characters. But it needs to be stated that the structural basis for this doctrine, however it may apply in animals, has no validity in the plant-body. In them there is no early segregation of somatic from propagative cells. These remain indistinguishable until a late state of individual development. In the absence of such structural segregation for plants, and in view of the positive evidence above advanced, we appear to be justified in concluding that in plants the distinction between fluctuating variations and mutations is not absolute.

¹ Bower, F. O., "The Ferns," vol. 1, Cambridge University Press, 1923.

In other words, characters that are seen to be adaptive in the individual life are apt to become hereditarily fixed; and in the progress of geological time this has happened repeatedly.

The impressive address of Sir Francis Darwin as president of the British Association in 1908 in Dublin should be recalled. The observations and conclusions relating to ferns which have been acquired in recent years appear to be susceptible of interpretation only through some form of mnemonic theory, such as he there disclosed. It is not only in the moral world, but perhaps also in the physical frame of living things that the methods of the importunate widow produce their result; and this will become the more plain where, as in the study of the ferns, the whole period of geological time from the Devonian Period onwards is available for the method to produce its structural effect. In recent discussions, too much stress has been laid upon the failure or success of laboratory experiments, which have extended at most over only a few years. Here in

the ferns we see evidence derived from experiments carried on naturally and continuously since the Palaeozoic age: and they indicate that adaptive characters are heritable. Preference should surely be given to those results which appear without any narrow time-limit. These show that, in the language of the mnemonic theory, engrams are imprinted upon the propagative cells. The impress of an engram in ordinary life may be, and probably is, a relatively rare event. The difficulty in producing satisfactory evidence of the inheritance of acquired characters in brief laboratory experiments in itself indicates a high resistance of germ-cells to their reception. But prolonged comparative study of ferns, with their long geological history taken into account as a check upon its results, appears to justify the view that in them the difference between fluctuating variations and mutations is not absolute. It indicates rather that characters acquired by adaptation in the individual life may become hereditarily fixed if secular time be available.

The International Research Council.

THE International Research Council held its third meeting at Brussels in the Palais des Académies on July 7 and the two following days. The first meeting took place six years ago, in July 1919, when the statutes of the Council were adopted, and steps were taken to form the Unions of Astronomy, Geodesy and Geophysics, Chemistry, Mathematics, and Radiotelegraphy. The second meeting was held in July 1922, when some additional countries were invited to join the Council, and the formation of the Unions of Geography, Physics, and of the Biological Sciences was agreed to.

Since the second meeting nine countries have joined the Council, so that the number of adhering countries up to the present time is twenty-nine, to which Latvia and Tunis have now to be added, having been admitted at this meeting: thus the total membership is now thirty-one. Of this total membership, however, only seventeen were represented on this occasion at Brussels, namely: Belgium, Czechoslovakia, Denmark, Egypt, France, Great Britain, Holland, Italy, Japan, Morocco, Norway, Poland, the Union of South Africa, Spain, Sweden, Switzerland, and the United States. The votes assigned to each country depend on its population, and the total number of votes controlled by the delegates was 52.

It was reported to the Council that the former International Seismological Association had been dissolved, with the assent of all the countries who were members of the Association. It was proposed that the Council should accept responsibility for such of the property of the Association as had been taken over, and this was approved. The work which this Association formerly carried out is now undertaken by the Section of Seismology in the International Union of Geodesy and Geophysics.

The most important business that was before the Council related to certain modifications of the statutes which had been proposed by Australia, by Denmark and Holland, by Sweden and by Switzerland. All of these, though differing slightly in form, had for their object the removal of the restrictions which now limit the membership of the Council and the Unions related to it

to those nations who joined in 1918, and others who have since been invited to join or have been elected under the existing statutes; these embrace only the Allies and neutrals of the War period, 1914-1918, the Central Powers being excluded. At the second meeting of the Council in 1922 a proposal was made to remove this restriction, but at that time it was not considered advisable to amend the statutes, and no action was then taken.

The procedure to be followed in modifying a statute lays down that "no change shall be made in the term of the Convention except with the approval of two thirds of the votes of the adhering countries." According to the president's calculation, the rule required 53 votes, so that even if a unanimous vote of all the delegates present had been obtained for any of the proposals, it would not have effected a valid change of statute. Thus although there was a majority of votes in favour of the changes proposed by Holland and Sweden, the statutes could not be altered. The situation, therefore, must remain as it was until the Council at another meeting comes to a different decision on this question, or agrees to modify the statute which requires a two-thirds majority of the votes, not merely of the countries present but of all the countries which belong to the Council. In the meantime the Executive Committee may by correspondence obtain a more representative opinion from all the adhering countries, for the statutes permit a country not represented by a delegate to vote by post.

The further proposal, submitted by France and Belgium, that membership of the League of Nations should qualify a country to be elected was not generally acceptable, and was therefore not adopted.

This result is in every way most unfortunate for international science: not only does it postpone the time when the Research Council will be truly international, but it also raises the question whether, as things stand, it will be possible to carry out the modification of any statute until the end of the present Convention in 1931. A full attendance of all the countries belonging to the Council at any meeting can scarcely be counted upon, though the votes of all c

them have to be taken into account in determining the two-thirds majority, so that a small group of dissentient votes may suffice to prevent a resolution being carried; or, as in the present case, a unanimous vote of those present may be insufficient to obtain the necessary majority. The serious inconvenience of this state of things was emphasised by several of the delegates at the present meeting, and the Executive Committee was requested to consider the situation, which must increase in difficulty as the membership of the Council is more widely spread over the world, with the view of suggesting a remedy.

The Council was not in favour of a proposal to rescind a resolution adopted at the meeting in 1922 requiring a country to join the Research Council before becoming a member of a Union.

A Committee which had been nominated provisionally by the Executive Committee in order to study the relations between solar and terrestrial phenomena was formally appointed by the Council for a period of three years, with power to add to its membership. The Committee will enter into communication with scientific men who are interested in the subjects to be studied by the Committee, especially those of countries which are not represented on the Committee. The

constitution of the Committee is: Prof. S. Chapman (chairman), Prof. G. Abetti, Dr. C. G. Abbot, Dr. C. Chree, M. H. Deslandres, General G. Ferrié, Dr. C. E. St. John, Dr. G. C. Simpson, and Prof. C. Stormer. The Committee held several meetings at Brussels on the present occasion. The Council had also before it a proposal from the International Mathematical Union advocating intimate co-operation between the Union and the Committee of Intellectual Co-operation of the League of Nations. As probably affecting other Unions also, the proposal was referred to the Executive Committee of the Council for consideration and report.

The period for which the president of the Council, M. E. Picard, had been elected having come to an end, his re-election was proposed by Prof. Lorentz and was unanimously agreed to. Dr. G. E. Hale and M. Lecoqte being unable for reasons of health to serve on the Executive Committee, Dr. V. Kellogg and M. P. Pelseneer were elected to fill these vacancies.

The Union of Pure and Applied Physics, and that of the Biological Sciences, held meetings at Brussels during those of the Research Council. In the Union of Physics the desirability of full internationality being attained at the earliest possible date was urged, and a resolution to this effect was passed unanimously.

Industrial Chemistry at Wembley.

THE visitor to the British Empire Exhibition who takes it *au sérieux* will find a plethora of good things to stimulate his mind, and if his bent is towards science or its applications he will revel in the exhibits of the Government Pavilion and in many of the attractions of the Palace of Industry. In the latter the signs and portents of chemical enterprise should convince him that the days of "dogmatic slumber" are fast disappearing, and that although British chemical industry cannot compare in magnitude with such industries as engineering, mining, shipping, and textiles, they are nevertheless of equal fundamental importance. As in 1924, the chemical exhibits have been organised by the Association of British Chemical Manufacturers, and the same commanding position in the Palace of Industry has been utilised.

Comparing the chemical section with that of last year, the visitor will notice the same excellent lay-out, though he may regret the absence of exhibits from a number of well-known manufacturers. This absence does not, however, seriously impair interest, and in some ways is an advantage, because undue multiplication of similar exhibits is avoided, and there is more space available for effective display. On the other hand, the presence of rather an excessive number of vendors of "cures," perfumes, hair-washes, and other proprietary toilet articles is apt to confirm the man in the street in his prepossession that chemistry begins and ends with pharmacy. Another noticeable absence, both this year and last year, is that of chemical exhibits from the Dominions Overseas. Nowhere in the Exhibition do we find any tangible evidence that our sister nations are striving to realise their war-time aspirations of industrial independence and of security against physical aggression through the medium of a well-organised and effective chemical industry.

Although many of the exhibits are the same as those shown last year, there are a number of interesting

novelties. The exhibit of Messrs. Burroughs Wellcome and Co. is a model of clear and attractive presentation, and its educational value is very high. Not only are medicinal and photographic chemicals displayed in artistic form and, where possible, in logical array, but concise information is also given concerning raw materials, methods of extraction, and preparation by synthetic methods; manufacturing operations are outlined, intermediate products are described, and miniature models of apparatus are exhibited. To attract the public there are crystals of various substances illuminated by coloured lights; and there is a very interesting display of historical relics—medicine-chests and first-aid outfits—carried by famous explorers, as well as dioramic views of the scenes of their activities.

Acids, alkalis, and other main products of the heavy chemical industry are so familiar that it must be difficult to devise new modes of display. Messrs. Brunner, Mond and Co., with their associated firms, have overcome this difficulty, partly by means of an attractive setting, and partly by exhibiting some up-to-date applications of well-known substances. Thus a number of new uses have been found for sodium silicate (of various composition), which has long been used in large quantities as a filling for soap (though it is said to have a slight detergent action). When mixed with powdered limestone it is now successfully used for hardening the concrete surfaces of roads, and the soft porous chalky limestone, which has hitherto been found useless for road-construction, has now found a valuable application. The mixture is sprinkled on to the prepared surface and then worked in with a soft broom. Three coats are applied, and the surface of calcium silicate so produced is more durable and more free from dust than surfaces made with the aid of coal-tar. Messrs. Brunner, Mond and Co. are also showing specimens of "grey pressed bricks," made of calcium silicate, which, though relatively heavy, are stronger and much less

pervious to water than common bricks, whilst their prepared surface renders unnecessary the use of plaster. Sodium silicate is coming into use as a means of preventing corrosion of water-pipes and cisterns, and of enabling aluminium utensils to withstand the action of hot solutions of soda. It is also used as an adhesive. Calcium chloride, a heavy chemical which for long awaited an adequate market, is used, *inter alia*, for spraying rubble tennis-courts to prevent the rising of dust.

The firm, Synthetic Ammonia and Nitrates, Ltd., shows a small case containing specimens of the products made in the nitrogen factory at Billingham-on-Tees. These consist of calcium nitrate, sodium nitrite, ammonium nitrate (not yet marketed), ammonium sulphate, and "agricultural chalk," which is calcium carbonate containing two per cent. of ammonium sulphate. In view of the enormous potential importance of this industry, the exhibit is disappointing. The mere display of products, most of them very familiar, gives the public no idea of the nature of the nitrogen problem and how chemists in all civilised countries are trying to solve it; and it should be possible to give the student and the technical man satisfying information without disclosing vital secrets of manufacture.

An interesting feature of the Brunner-Mond display is a continuous automatic-lantern exhibition depicting bird's-eye views of factories, the loading and unloading of goods, methods of transport, offices, etc., connected with this firm's world-wide activities. Messrs. Chance and Hunt, Ltd., are showing, in addition to their staple products, specimens of ferrous chloride, which is now used in making jointless magnesite flooring. The Castner-Kellner Alkali Co. has a small exhibit relating to the use of liquid chlorine and of chlorine derivatives of ethane and ethylene, bleaching agents, etc., whilst Electro-Bleach and By-products, Ltd., makes a special point of its sesquicarbonate of soda, which is a very concentrated form of soda for cleaning and other purposes.

Messrs. Albright and Wilson, Ltd., well known for their manufactures of phosphorus, show interesting exhibits relating to the fire-proofing of wood and the preservation of stone. By means of the "Oxylene" (secret) process, owned by the Timber Fire-proofing Co., Ltd., of Market Bosworth, wooden safes and their contents can now be protected from the effects of exposure to high temperatures. A deal fire-proof door is shown, one side of which became covered with adherent non-conducting charcoal on exposure to flames at a temperature above 900°C ., whilst the other side barely became hot. The merits of Prof. A. P. Laurie's "silicon ester" as a means of preventing decay of building-stone are effectively indicated by specimens of treated and untreated materials. "Silicon ester" is made by the interaction of alcohol and silicon tetrachloride, and it acts by depositing silica in the pores of the stone, thereby strengthening it but not affecting its permeability. One of the chief attractions in the stand of the United Alkali Co. is an educational exhibit of "intermediates" derived from coal-tar, so executed as to bring out their genetic relationships. The Salt Union, Ltd., shows that it is moving with the times by displaying a table-salt which, as the name

"Salodine" suggests, contains an iodine compound; and the British Cyanide Co., Ltd., exhibits a new colourless and odourless synthetic resin, made from thiourea, which is well adapted for making insulating materials and moulded articles like cups and saucers.

This year the dyestuff-makers have largely discarded strictly technical exhibits, and have co-operated in presenting artistic displays and colour schemes. Instead of being met with the usual array of bottled products, the eye is at once attracted by two large tents, with revolving tops, and a long corridor, all draped with coloured fabrics. Around are displayed articles, from carpets to candles, coloured with British dyes. Fine chemicals are well represented by Messrs. A. Boake Roberts and Co., the Graesser-Monsanto Chemical Works, Ltd., the Clayton Aniline Co., Ltd., Thomas Tyrer and Co., Ltd., B. Laporte, Ltd., and a number of others. In the exhibit of the first-named there is a good model of a three-column distilling plant by Messrs. Blair, Campbell and McLean.

Our two largest gas companies are, as usual, to the fore with luxurious displays, and there is an attractive co-operative exhibit by tar-makers of a rustic scene with an inn, garden, bridge, a tree with mechanical singing-birds, and a country road made up with "Tarmac." Unfortunately, the recent report of the Standing Committee on Rivers Pollution has severely condemned the use of tar on roads, because the washings are toxic to fish, particularly when the road surface is broken up, and it enjoins the use of bitumen instead. By way of counterblast there is shown in the scientific section a shallow tank containing live fish and plants supplied by water running over channels prepared with "specially refined" tar. Although the conditions in the tank are scarcely comparable with those in a stream, the exhibit is ingenious and attractive to the passer-by.

The scientific section is hidden away in the midst of the industrial chemistry exhibit. Its position may perhaps be justified as indicating that scientific research is the "heart" of chemical industry. The exhibit this year is devoted to educational exhibits relating to coal, salt, and food. The coal exhibit is the most comprehensive, containing excellent models of plant, but all are good. A small exhibit illustrating the properties, etc., of viscose and cellulose "silks," and that of some products obtained in the "Berginisation" of coal, increase the interest of this valuable section.

In the above account it has not been possible to mention more than a few of the exhibits, but there are many more of a high order. Those who are responsible for the success achieved during the two sessions will, doubtless use the experience gained to do even better in the future. The tendency, already shown, to find substitutes for "bottled" products should be encouraged; there should be more models of plant and apparatus, and—what is entirely lacking in the present exhibition—economic information conveyed in the form of charts and diagrams. Those who stand for science in industry appreciate the fine efforts which so many chemical manufacturers have made in connexion with this exhibition; they would be even more appreciative if their thirst for knowledge could be assuaged by conversation with a few technical men who might be specially detailed to explain or demonstrate the processes and products displayed.

Recent Researches on the Causation of Tumours.

By Prof. WILLIAM BULLOCH, F.R.S.

A WEEK or two ago it was rumoured that remarkable additions had been made to our knowledge of tumours by Dr W. E. Gye, of the scientific staff of the Medical Research Council. Instantly, almost every newspaper took the report up, some of them announcing with sensational headlines that the problem of cancer was solved and that the disease was due to a small germ. Dr. Gye's collaborator, Mr. J. E. Barnard, F.R.S.—a well-known scientist—was said to have secured photographs of the virus, and it was alleged that it had actually been cultivated. What the real facts were, was only the property of a few, because the papers of Gye and Barnard were not published until some days later. In the absence of details, a short note appeared in *NATURE* of July 18—the day of publication of Gye's paper—giving a general statement of the results said to be claimed, and so far as they were known. It is now possible to write more fully and with greater confidence as a result of the study of the papers just published (*Lancet*, July 18).

Unlike many fantastic hypotheses which have been proposed to explain the cause of tumours, the present one comes from a scientific worker who has the very highest credentials and is known not only in England but also all over the scientific medical world. Behind him is a wide experience, particularly of the kind of work on which he now reports, and he is known for his imaginative and critical powers, his sober judgment, and his high technical skill.

William Ewart Gye is a man about forty years of age who graduated M.D. Edinburgh in 1913 and came to London to be assistant in the laboratories of the Imperial Cancer Research Fund about a dozen years ago. His appearances in scientific gatherings stamped him at once as a quite unusual man, modest but efficient, full of scientific enthusiasm, but temperate and cautious in the estimate of his own work and that of others. During the War he carried out very important investigations which cleared up several of the mysteries in the pathology of gas gangrene and lockjaw and secured him a post on the staff of the Medical Research Council. When the Council inaugurated a scheme for the study of the unknown viruses of certain infective diseases, like distemper, Gye took his part, but early struck out on his own lines and, working by himself, has completed the research just published. This work is of the greatest interest and, if confirmed, will be found to open up entirely new fields not only in what has hitherto been a veritable slough of despond—cancer—but also in connexion with many other diseases, of unknown causation, affecting man and animals. Gye's paper in the *Lancet* is entitled "The Ætiology of Malignant New Growths" and is prefaced by a short paragraph quoted from a leader on the subject in the same issue. It is unusual and often unwise to attempt to forecast what the ultimate value of a scientific paper will be, but the *Lancet* is of opinion that the two papers of Gye and Barnard "mark an event in the history of medicine." This may or may not be so, and we may note that the leader writer, in the next sentence, is more moderate when he states that they may present a solution of the central problem of cancer.

The critical study of Gye's paper leads one to the conclusion that, if his results are confirmed by independent workers, he has made a discovery of the greatest interest and possibly of the highest importance to the well-being of man. Before dealing with his data as presented, and as the subject is one which will be followed by scientific as well as non-scientific readers, it would appear well to clear the ground and state what was commonly accepted on the subject of malignant disease before Gye's publication, and it may be affirmed at once that but little of this knowledge has been controverted by his work.

It is known that all races of man and animals are liable to the development of tumours or swellings—now called blastomata—which possess certain common and constant features. No tumour has yet been seen that was not composed of some tissue of the body of the individual in which it arose. For some unknown reason a tissue begins to grow in excess, and this growth, barring operation or accident, is unlimited in extent. There is an infinite variety in the structure of tumours arising from different or even from one and the same tissue, and quite early an important line of demarcation was drawn on practical grounds between tumours that were clinically or histologically benign and those which were malignant and destructive of life. The differentiation is, however, not always easy, or indeed always possible. From remote times, two special malignant tumours have attracted interest on account of their deadly character. These tumours—sarcoma and cancer—start in a particular tissue but early burst into other tissues. Invading blood-vessels and lymph vessels, and being swept away in the circulating blood, the cells are carried throughout the body, halting in numerous backwaters to produce secondary tumours or metastases. There is an irrefutable body of evidence, confirmed daily, that the secondary tumours are composed of cells which are the descendants of the cells of the primary tumour.

The central problem of tumour formation is to find out what has caused this aimless growth of cells previously—so far as one can judge—perfectly normal. It is this problem which Gye has attempted and is reputed to have solved. There have, naturally, been many hypotheses on the subject of the cause of tumours, but two have gradually been accepted as the most probable. In one, evidence has been sought experimentally and otherwise that the purposeless growth of the cells is due to some kind of chemical irritant acting on normal, or possibly abnormal, cells. The other view, early held and long studied, attributed the cause of tumours, particularly malignant growths, to the action of some extrinsic parasite which, entering the body, stimulated the cells to unwonted activities. Many parasites of microscopic size have been incriminated at various times during the last forty years, but none has fulfilled the test of tumour production experimentally, and however much the study of malignant disease suggests an infection, the vast majority of those with special knowledge were compelled to reject a parasitic hypothesis on various grounds. No parasite, not even that said to exist by

Gye, has by its inoculation caused by itself the development of a malignant or other blastomatous growth. Further, there is a marvellous specificity in all growths whereby they copy, in every degree of variation, the tissue from which they arose. Those facts forced investigators to the conclusion that, when one remembers the extraordinarily wide zoological range in which tumours occur, the cause is some deep-seated mystery connected with the processes of birth, growth, and decay of the cells of the body.

In 1902, C. O. Jensen, of Copenhagen, discovered by accident a malignant tumour in a mouse, and worked it out so carefully that his paper has become a classic in the literature. He failed to find any evidence of a parasite either in the original growth or in those transmitted by transplantation to other mice. He showed that no growths followed the inoculation of tumour cells that had been crushed. Since Jensen's time, many similar tumours have been studied and transmitted in an unbroken series of generations, and Jensen's statements have been confirmed over and over again. Even before Jensen, several workers, among whom we may specially mention Bellingham-Smith and Washbourn in England, had shown that certain tumour-like formations were transmissible from dog to dog, but the exact nature of the growths was the subject of much dispute.

In 1910, a new, and, as it proves, highly important, work was published by Peyton Rous, of the Rockefeller Institute, N.Y. He found a tumour growing in the breast of a barred Plymouth Rock hen. The tumour proved to be transmissible to other hens of the same setting, and in structure was regarded as a genuine sarcoma. Transmission, at first, was not easy, but in the course of passage from one fowl to another the growth became more malignant in its effects and lethal within a few weeks. In 1911, Rous made the further, highly important, discovery that when portions of the sarcoma were ground up and passed through filter paper, or even through a Berkefeld Kieselguhr filter, the cell-free filtrate contained some "agent" which could communicate the sarcoma disease to normal fowls. No microbe could be seen in, or be grown from, the clear filtrate, and Rous left it an open question whether it was to be regarded as containing a living microbe. "It is conceivable," he said, "that a chemical stimulant elaborated by the neoplastic cells might cause the tumour in another host and bring about in consequence a further production of the same stimulant."

The fact that the cell-free filtrates were capable of producing tumours was something quite new, but was soon found not to be unique, for between 1911 and 1913 Rous, in conjunction with Murphy, Tytler, or Lange, found two other fowl tumours transmissible in this way. He also showed in the case of the first tumour ("Rous sarcoma I.") that ultra-violet light rapidly destroys the activity of the sarcoma cells without destroying the filterable agent associated with them. From irradiation experiments he made out that in the sarcomatous tissue there are apparently two elements capable of producing the growth. One will withstand drying, the other will not. The latter is the living transplantable cells, whereas the former is the tumour-producing agent.

Coming to Gye's work, full credit is given to Rous for his admirable researches on the Rous sarcoma I. It is with this tumour that Gye has mostly made his experiments. His main thesis is that the "agent" is really a living virus. This virus is incapable by itself of producing a tumour. For the latter, there has to be the co-operation of a second factor—the "specific factor"—also incapable by itself of inducing a sarcoma, but which enables the living virus to attack the cells of the inoculated animal and transform them into malignant cells. The impression gained from a careful perusal of Gye's paper is that he has more facts than he has yet divulged. The experiments he has given us are carefully thought out and precisely described. A medium—probably not the best one—is indicated in which he obtains "primary cultures"—"a term of convenience," he says, applied to the result of placing a fragment of tumour in the medium. He found that in a tube of "primary culture" the supernatant liquor becomes infective, depending on various factors of which anaerobiosis is said to be the most important. That the "primary culture" contains something living is suggested by the definite acid reaction which ensues when glucose, maltose, or levulose are incorporated in the medium. No such reactions occur in the presence of mannitol, lactose, or sucrose. It is believed that the "agent" of the tumour diffuses out in the medium and that it disappears slowly (days).

Of fundamental importance for the support of Gye's views are his experiments on the action of chloroform on the tumour agent. It had been previously shown by Rous that carbolic acid, toluol or chloroform destroys the power of the "agent" to induce tumours. In a series of experiments, repeated, it is stated, with constant results, Gye shows that a "primary culture" incubated aerobically for three days at 37° C. produced no tumour when injected into fowls. The clear tumour filtrate thoroughly treated with chloroform was also incapable of inducing growth. But the two inert fractions mixed together were found to produce typical sarcomata. The interpretation given by Gye is that the chloroform-treated filtrate contains a labile chemical substance which in some way, unknown, renders the cells susceptible to the supposed virus, presumed to be present in the other fraction, which was incubated at 37° C. for three days. Gye's conception of a double factor was also supported by centrifugation experiments, for although it was not found possible to drive the virus to the bottom of the tubes spun at high rates, some concentration in special lined tubes did appear to occur. Of the two factors necessary for the production of a Rous sarcoma, Gye believes that one is particulate and is therefore "probably a virus," the other, uninfluenced by centrifugation, being a chemical substance. Since the supposed virus is incapable of producing a tumour, and since the tumours when they originate are specific, Gye admits that the "specific factor" must be the important thing when the action of the two is considered.

Attempts were made to demonstrate that the "virus" actually multiplies in cultures. In one experiment, a fifth subculture in direct line from a "primary culture" produced no tumour, nor did a chloroformed filtrate, but when the two were mixed,

tumours were produced and were lethal in twenty-three days. As each subculture represented a dilution of 1000 fold, the dilution of the matter in the "primary culture" would be 10^{15} if it had not increased.

These remarkable results with the Rous sarcoma I. were followed up on other tumours of known origin and history. They included a spindle cell sarcoma "37/S," the Jensen rat sarcoma, carcinoma of mouse "No. 63," and a rat sarcoma known as "No. 9." Directly or indirectly, experiments with these tumours confirmed the results with the Rous sarcoma I. In each case the "specific factor" was the important one, the virus being less so. Thus a chloroform extract from Rous sarcoma was found to be incapable of producing the disease. A "primary culture" from mouse cancer "63" was also inert when tested on fowls. The specific factor of the fowl plus the "culture" from the mouse produced sarcoma in the fowl. This astonishing result was also obtained in the case of an adenocarcinoma of the human breast. Inert "specific factor" from fowl tumour, plus inert "primary culture" from human tumour, caused sarcoma in the fowl.

That briefly and perhaps imperfectly represents the main results of Gye's published work. Of the proof of the "virus" he speaks guardedly. It is said to be "almost certainly a virus." The idea of two factors in the production of a disease is not a new one. It has, indeed, long been a commonplace of medical writers that the development of most diseases requires the co-operation of two sets of factors. On one hand, the organism within which the morbid process is to unfold itself must conform to certain conditions of structure and function. This is the so-called "internal" cause. On the other hand, some agent, the "external" cause, actually or functionally outside the organism, must exert an effect peculiar to itself, and a property of its own structure, upon the organism which is in

process of becoming the seat of the disease. The revolutions in medical knowledge which came from bacteriological discoveries showed that for most, infective diseases the specific agent was the external one. Thus the tubercle bacillus is the specific element in tuberculosis. In the case of tumours—if Gye's work is confirmed—it would appear that the specificity is not resident in the virus but in the "internal" cause—a new conception in connexion with infective disease. Gye's work may be the central point round which the cancer problem revolves. It is certainly a long way from the complete solution of tumour formation, although one must be frank and congratulate Dr. Gye on opening up a new field pregnant with possibilities.

With reference to Mr. Barnard's paper, this deals largely with the question of the microscopic examination of "ultra visible" agents. The agent chiefly described is the microbe of bovine pleuro-pneumonia, in which various morphological types are reproduced. Very little is said of the "virus" of Rous sarcoma, and other tumours except that the same morphological types can be seen as occur in bovine pleuro-pneumonia. Attention is directed to the care necessary in excluding various "bodies" which are seen in uninoculated tubes. Finally, there is a combined note by Gye and Barnard. Their exact words may be here reproduced. "Our belief that the small bodies seen and photographed are the actual virus depends partly upon the fact that control uninoculated tubes of medium have been invariably blank and partly upon the correspondence between the microscopical findings and the results of experiments on animals. This correspondence—allowing for the real difficulties in both parts of the common task—has been so close that although final proof has not been attained we are convinced that our conclusions are sound."

Current Topics and Events.

PRIOR to the War, there was in force an Order of the Board of Agriculture compelling the slaughter of cattle discovered to be suffering from tuberculosis of the udder and giving partial compensation to their owners for this compulsory action. This Order is about to be renewed for all cattle suffering from tuberculosis of the udder or from tuberculous emaciation, one-fourth of the market value if the disease is advanced, or otherwise three-fourths, being given to the owner. In these circumstances it will be interesting to ascertain how many are certified as suffering from advanced disease. From the same date the use of any cow for producing milk which gives tuberculous milk will be prohibited, and owners and veterinary practitioners are required to notify tuberculosis in cattle so soon as recognised by them. The last paragraph of the circular letter announcing the matter briefly summarised above adds somewhat deprecatingly: "The new Order represents the most that is practicable at the present time in the direction of securing the eradication of bovine tuberculosis, and in contributing to the production at the source of a milk supply free from bovine tubercle bacilli."

THIS statement on the official attitude in Great Britain towards bovine tuberculosis is commendably frank, and adequately reveals the weakness of the situation and the action—or is it merely "gesture"?—directed towards remedy. Disease is allowed to continue to become obvious to the farmer, and so obvious that he can no longer conceal it, or until a veterinarian is called upon the scene, and then the local authority—hereafter three-fourths of the money probably will be paid out of Exchequer funds—will pay three-fourths or one-fourth of the value of the condemned beast. There are some hundreds of herds of cattle in Great Britain from which tuberculosis has been eliminated by well-known and practicable scientific methods. Is it not likely that the resumption of compensation to the owners of beasts with advanced tuberculosis will delay the multiplication of tuberculosis-free herds? Moreover, is it not arguable that, in the interest of the many thousands of young children in Great Britain who annually are made victims of tuberculosis from drinking infected milk, it might be better to save the millions sterling which will be paid in compensation for disease which

has already in large measure done its lethal work, and in lieu of this belated attack on disease, to issue an Order demanding pasteurisation under strictly regulated conditions of all cows' milk not derived from a tuberculosis-free herd?

PRACTICALLY all the senior radio officials of every European State were present at the conference of radio engineers held at Geneva on July 6-8. The question of broadcasting has become one of great urgency as there are more than 110 stations in Europe which are sending out ether waves, the lengths of which in several cases are nearly identical. As a separation of frequencies of 20 kilocycles is desirable to prevent interference, and as the limits of broadcasting frequencies are narrow, it was found quite impossible to give to each station, existing and projected, an exclusive frequency. It was necessary, therefore, to give to some stations small in power the same frequency as other stations remote from them. Engineers, however, are not certain that when all the stations are in operation simultaneously there may not be serious interference in certain places. They therefore hope to make experiments about midnight in the early days of September, when it is arranged that all the European stations will broadcast simultaneously. Owing to the practical difficulties in the way of standardising frequencies within narrow limits, it is anticipated that in several places listeners will have difficulty in tuning out interfering stations. Plans have been made to meet again at Geneva to discuss the experimental results. It is proposed to transmit from a large European station signals of given frequencies so as to enable all the broadcasting stations to check their waves. It is interesting to notice that Great Britain has the largest number, 20, of existing stations, Germany comes next with 16, and then France, Spain and Sweden with 12 each.

At the International Conference of Women in Science, Industry and Commerce, held at the British Empire Exhibition, Wembley, on July 15-17, Miss H. M. Davis read a timely paper on electricity in mines. Miss Davis pointed out that the main costs of mining coal are due to manual labour and mechanical power. The large and increasing use of electricity has enabled many economies to be made. The modern electrical coal cutter is highly efficient; although it stands on only a few square feet it is capable of developing 40 h.p. The conveyors are operated by specially constructed motors, and the tubs into which the coal has been loaded from the conveyors are taken to the bottom of the shaft by electric haulage. The winding equipment at the pit-mouth is often now operated electrically. In addition, electricity is used for pumping, ventilating, compressing air, coal washing and many similar purposes. Unfortunately, the colliery load factor, that is, the ratio of the actual energy consumed per week to the total energy that could have been consumed if the pit were always working, rarely exceeds 50 per cent. Increasing the number of pits supplied by a central station has little effect on the load factor, and hence supplying a large number of pits from a large common

central station does not necessarily lead to increased economies. Miss Davis concluded that unless power can be supplied to the collieries at a price of about 0.7d. per unit, most colliery companies would be well advised to generate their own power. Provided, however, that the winding shifts could be arranged so that the load factor was reasonably constant, a great reduction in the power costs could be effected. If all the workers co-operated it would be possible to achieve this result in practice.

THE aim of the recently opened Research Institute in Animal Pathology, Royal Veterinary College, London, is to increase knowledge regarding the diseases of the domesticated animals, and the subjects selected for investigation from time to time will be those which appear to be of the greatest importance, either on account of the loss which they cause to agriculture; or because of their connexion with disease in the human subject. In the immediate future, investigations which have for some time been in progress will be continued with regard to Johne's disease, abortion in cows and mares, and quarter-evil. It is intended also to bring under investigation diseases caused by parasitic worms in lambs and calves, and calf diphtheria. Parasitic diseases are annually the cause of great loss throughout Great Britain, and there is evidence that few, if any, of the methods at present employed are efficacious for destroying the worms within the body. The cause of calf diphtheria has long been known, but in the present state of knowledge it is scarcely amenable to treatment. An effort will be made to discover a method of vaccination by which the disease may be prevented in young animals exposed to risk of infection. Although the Institute is well equipped from a scientific point of view, it is realised that laboratory investigations in order to be fruitful generally require the collaboration of stock owners and practising veterinary surgeons, and the Director wishes it to be widely known that the Institute is a place to which the members of both these classes may appeal for advice and assistance in connexion with any serious disease which appears to them to require investigation.

It may be remembered that the protection of scientific discoveries which are not inventions and as such are incapable of being patented was the subject of a report to the League of Nations in 1923 by Senator F. Ruffini (*NATURE*, April 26, 1924, and May 3, 1924). The League has now published replies which it has received from the Government of Finland, the Irish Free State, and the Government of Hungary (*League of Nations*; C. 217, M. 74, 1925, xii). The Government of Finland, while acknowledging the injustice of the laws which deny protection to the intellectual work of the man of science, considers that the suggestions propounded by Senator Ruffini could usefully be applied in the case only of a few branches of science such as physics and chemistry, and to some extent physiology and medicine. It admits, however, that this restriction of the field of application of proposed protection is not a sufficient motive for rejecting the scheme. It points out that scientific

investigators do not work for economic profit as a direct result of discoveries, and that to some extent they are compensated by public recognition and by the conviction of having done work for the good of humanity. After enumerating difficulties in the application of the League's proposals, the reply adds that the matter is to be brought up at a Congress of Jurists to be held at Helsingfors in August next. The Irish Free State concurs in the opinion that the originator of a valuable scientific discovery is entitled to receive material recognition for his work, but it is not satisfied that the proposals outlined in the draft convention which accompanied Senator Ruffini's report are capable of satisfactory adoption.

THE Government of Hungary, referring to Senator Ruffini's report, states that while in the opinion of all nations inventions can only be effectively protected when their practical work has been demonstrated in concrete form, the proposals made aim at protecting inventions at a stage when they have not yet had an opportunity of proving their value. It points out, however, that an obligation of affording to intellectual work the legal protection asked for by the League has already been conceded by certain Provisional Rules of Jurisdiction laid down in 1861, although the law regarding authors' and inventors' rights does not give complete application to this principle. The Hungarian Government hails Senator Ruffini's proposals with the greatest satisfaction, but is not convinced that the methods suggested would in practice be the best. It considers that an agreement ought first to be arrived at between States, in virtue of which each country would undertake to amend and develop its own laws with the view of ensuring the most effective protection of intellectual work, and that when these changes have been made, the various countries should conclude an international convention under which they would mutually support each other in affording protection to intellectual production.

THE advantages of co-operation and fear of German and other foreign competition were the keynotes of the speeches made at the ninth annual meeting of the Association of British Chemical Manufacturers, held on July 9, in London. Mr. Milne Watson, the chairman, referred to the growing spirit of co-operation between the dyestuffs industry and other branches of chemical industry. This industry is in a difficult position, but the same may be said of the dyestuffs industries in the United States, Italy, France, and Japan, whilst even those of Germany and Switzerland have their troubles. British dyestuff manufacturers will have to double their efforts before the home industry can be said to be safely established on an adequate scale. The fine-chemical industry has had a fairly quiet time, but a strenuous year awaits it, for in 1926 the Safeguarding of Industries Act expires, and the Government will want to know what progress has been achieved during its duration. Our manufacturers are already taking stock of the position. Dr E. F. Armstrong complained of the difficulty in finding suitable chemists possessing the necessary broad outlook,

and he hoped the Association would induce the universities to alter their course of training. Several speakers emphasised the danger of increased competition from Germany, which, it was stated, is now more serious than it was in 1914. German manufacturers have eliminated competition at home, all the smaller firms have been absorbed in the large ones, plant that was not absolutely up-to-date or capable of reconstruction has been scrapped, reports on labour are uniformly good, the burden of overhead charges has been removed, and the only apparent trouble is lack of liquid capital.

MR. E. J. WAYLAND, director of the Geological Survey of Uganda, has sent us a further letter upon the subject of the paragraph on "Petroleum in Uganda," to which he took exception in a letter published in NATURE of June 27, with the contributor's reply to it. We are not publishing the letter, but it may be remarked that the correspondence has once again directed attention to the petroleum resources of Africa. By the modern school of geological thought it is now generally conceded that the most trustworthy basis of assessment of future resources is that of geotectonic and stratigraphical achievement, and that apart from manifold indices of bitumen (using the word in its widest sense), favourable prospects are alone deducible from the observed occurrence of suitable mother-rocks, reservoir rocks and externally impressed structures, while the problem of recoverable commercial supply rests ultimately with the drill. Now, excluding the Atlas region of the north, tectonically European (Alpine) in its affinities, and the Red Sea region of the north-east, Africa, by virtue of its great antiquity, the nature of its rocks and broad similarity to vast plateaux such as those of Brazil or the Indian peninsula, seems to lack those geological desiderata usually regarded as essential to the genesis, concentration and permanence of large oil-pools, comparable, for example, with those of Burmah, Persia or Rumania; thus arguing on first principles, by analogy, and also from the results of several past unsuccessful ventures in the search for petroleum along the east and west coasts, in the Transvaal, and in the interior (e.g. south of lat. 25° N.), many have been confirmed in their initial scepticism of the oil potentialities of this great continent, as in similar cases of northern Canada, Brazil, southern India, Arabia, Siberia, Australia, etc. It is none the less a welcome sign that certain African geological surveys include research for petroleum in their programme, and while some people may be sceptical of ultimate commercial results, the scientific importance of such work is unquestioned.

ON May 17-24, representatives of the geophysical institutions belonging to the numerous republics of the Soviet Union gathered in Moscow for the first scientific Congress of Geophysics. Beside scientific work this assembly had to deliberate on a number of questions of organisation in quest of the right way of resolving a most complicated problem, that of the co-ordination of the geophysical service in a country

so extensive as the Union of the Socialist Soviet Republics. The scientific work of the Congress was discussed by the following five sections: (1) meteorology, aerology, and general topics; (2) actinometry, electro-meteorology, atmospheric optics, and acoustics; (3) climatology; (4) dynamic and synoptic meteorology; (5) terrestrial magnetism, seismology, and graviometry. Beside these five sections a special commission for the study of drought and its peculiarities was organised. 335 reports were presented for the consideration of the assembly, 75 relating to questions of organisation and 260 scientific reports. There were no less than 511 delegates at the Congress.

THE third International Congress of Entomology opened its meetings at Zurich on Monday, July 20, after a reception of the delegates on the evening of Sunday, July 19. The first of these Congresses was held at Brussels, and the second at Oxford. In August 1914 the third was to have met at Vienna, but circumstances made this impossible. Science, however, is international, and "Time the Healer" suggested the resumption of these meetings, and Zurich was chosen as neutral ground. About 200 members are in attendance, 60 of them from Britain. Nearly all the European countries are represented—though there are significant exceptions—as also India, Canada, South Africa, and the West Indies. The United States is represented by Dr. L. O. Howard and others, while there are representatives from Egypt and Mexico. Switzerland is naturally well represented, and the president is Dr. A. von Schulthess. A very full programme has been arranged under the sections morphology, systematic entomology, biology and development, bionomics, and nomenclature. The social side has not been forgotten. In addition to evening meetings for social intercourse, an excursion has been arranged to the Uetliberg, one of the highest points in the neighbourhood of Zurich, from which good views of surrounding peaks may be had; and a sail round Lake Zurich. A banquet is being held on the night of July 24. On July 25, after some sectional meetings in the forenoon a general business meeting is being held, at which the time and place of meeting for the next Congress will be arranged.

THE Trustees of the late Sir William Dunn have made a donation to the Medical Research Council of 2000*l.* per annum for a period of five years to be used for the promotion of research work in medicine at the discretion of the Council. The Medical Research Council, in accepting this generous benefaction, has intimated that for the present this special Dunn Fund will be applied mainly to the furtherance of the organised studies of filterable viruses which it is supporting, and in particular to the recent developments of this work in relation to cancer by Mr. J. E. Barnard, Dr. W. E. Gye, and their colleagues. It will be recalled that the Dunn Trustees have already made many important benefactions for the advancement of medicine. They have endowed a chair of pathology at Guy's Hospital, London, and erected a School of Biochemistry and endowed a chair in biochemistry, now held by Sir Frederick Hopkins, at

Cambridge; they have given a new building for the School of Pathology at Oxford, now being erected, and have provided equipment for the School of Pharmacology there. They have also built and equipped laboratories for the University Medical Clinics at St. Bartholomew's Hospital, St. Thomas's Hospital, and the London Hospital.

AT the annual general meeting of the Faraday Society, held on July 6, the following officers were elected: *President*, Prof. F. G. Donnan; *Past-Presidents*, Sir Robert Hadfield, Prof. Alfred W. Porter, Sir Robert Robertson; *Vice-Presidents*, W. R. Bousfield, Prof. C. H. Desch, Dr. W. H. Hatfield, Prof. W. C. Lewis, Mr. C. C. Paterson, Prof. A. O. Rankine, Dr. E. K. Rideal; *Treasurer*, Mr. R. L. Mond. During the past year general discussions on the following subjects were held: (1) "Fluxes and Slags in Metal Melting and Working," (2) "Physical and Physico-Chemical Problems relating to Textile Fibres," (3) "The Physical Chemistry of Igneous Rock Formation," (4) "Base Exchange in Soils." It is the policy of the Society to co-operate wherever possible with other scientific societies, and three of these discussions were held jointly. The policy of co-operation is also extended to the American Electrochemical Society, in that by a mutual arrangement the Transactions of each society are supplied to the members of the other society at a special rate. In addition to the general discussions, four ordinary meetings were held. One section of the Report refers to the convention that should be adopted as regards the sign of the potential on an electrode. The Council is not prepared to make an official pronouncement on the subject, and the opinion is expressed that such matters should be settled by international agreement. During the year thirty-three new members were admitted to the Society. There was an adverse balance of 293*l.* on the year's work, due to the great amount of material published. While loth to diminish the Society's activities, it has been decided to limit the general discussions for the time being to two a year, and it is expected as a result to balance income and expenditure during the present year.

ACCORDING to the annual report of the Trustees of the Beit Memorial Fellowships for Medical Research, there were last year 93 fellows on the Fellowship register and 23 Fellowships were occupied. Further elections have taken place as follows. Senior Fellowship (600*l.* per annum for 3 years), Mr. H. D. Kay; 4th Year Fellowships (400*l.*), Mr. E. B. Verney and Mr. J. L. Rosedale. Seven Junior Fellowships (350*l.* per annum for 3 years) were also awarded, and the nature of the proposed research and place where the fellowship is tenable appears after the name of the new fellow. Dr. G. H. Eagles, to study the specific agglutinogenic properties of streptococcus scarlatinae and the possible further specific grouping of hæmolytic streptococci occurring in other pathological processes (The Lister Institute of Preventive Medicine, London). Miss D. M. Needham, (1) a study of the oxidation-reduction potential of various organisms and tissues; (2) a continuation of the study of the pancreatic factor inhibitory to lactic acid formation.

in muscle (Bio-chemical Laboratory, Cambridge). Dr. E. N. Chamberlain, effects of the anterior lobe of the pituitary gland on the liver and other organs of the body; investigation of the relation of pituitary and other ductless glands to cholesterol metabolism and their inter-relationships (Johnston Laboratory of Bio-Chemistry, University of Liverpool). Mr. E. N. Allott, the growth of bacteria on artificial media: to attempt to grow bacteria on purely artificial media, consisting of simple compounds, such as simple sugars, amino acids, and salts (Bio-Chemical Laboratory, Cambridge). Mr. F. C. Kelly, to continue research on iodine metabolism, especially the iodine requirements of animals and the influence on nutrition of diets deficient in iodine (Bio-chemical Laboratory, Cambridge). Mr. D. E. Denny-Brown, to investigate spastic paralyses, decerebrate rigidity, and allied conditions, more particularly with regard to the influence of the sympathetic nervous system upon them (Physiological Laboratory, Oxford). Mr. B. S. Platt, the relationship existing between the formation of peroxides by bacteria and certain of the phenomena of immunity (Bacteriological Laboratory of the Department of Pathology, The School of Medicine, Leeds). Thus three of the new fellows of the seven will be at the Biochemical Laboratory, Cambridge.

WE regret to announce the death, on July 14, at the age of sixty-seven years, of Dr. F. E. Beddard, F.R.S., formerly prosector of the Zoological Society, London, and naturalist to the *Challenger* expedition, who was distinguished for his work on the Oligochaeta and on the structure and classification of birds.

Our Astronomical Column.

RETURN OF WOLF'S PERIODIC COMET.—The opening, on July 13, of the meeting at Cambridge of the International Astronomical Union was marked by the detection, by Dr. Stobbe at Bergedorf Observatory, of this interesting periodic comet, which has been observed at nearly every return since its discovery in 1884. Prof. Kamiensky, Director of the Warsaw Observatory, was present at Cambridge and received many congratulations on the brilliant success of his prediction, the error of his predicted place was only 4', although the perturbations by Jupiter at the last return were so enormous, that the perihelion distance has been increased by an entire astronomical unit, the orbit having, in fact, reverted to its form of fifty years ago when Jupiter acted to reduce the perihelion distance. The perturbations during the whole fifty years have been investigated by Prof. Kamiensky, and the successful prediction gives evidence of his skilful and accurate work.

The comet was of magnitude 15 at rediscovery on July 13, and will remain too faint for ordinary telescopes throughout the apparition. It will, however, be brighter by a magnitude or two when it reaches perihelion on November 8.

Brooks' Comet, the perturbations of which have been investigated by Prof. Dubiago, also suffered large disturbances by Jupiter at aphelion, and is also due at perihelion on November 8. Search for it and for Faye's Comet (due at perihelion about August 6) is now being made. Borrelly's and Kopff's Comets are also due in a few months, so that comet searchers are being kept busy. Tempel's Second Comet has brightened considerably, and is now an easy telescopic object. It has a short tail.

THE Civil Service Commissioners have appointed Mr. A. C. Stephen, at present a junior naturalist on the scientific staff of the Fishery Board of Scotland, to be assistant in the Natural History Department of the Royal Scottish Museum, Edinburgh, in succession to Dr. E. L. Gill, recently appointed Director of the South African Museum, Cape Town.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: A lecturer in chemistry and physics at the Exeter Diocesan Training College for Schoolmasters—The Principal, St. Luke's College, Exeter (July 31). A botanist (temporary post) at the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W. 1 (August 5). A resident tutor for mathematics and physics at the Borough Road Training College—The Secretary, British and Foreign School Society, 114 Temple Chambers, Temple Avenue, E.C. 4 (August 8). Two junior engineers at the Forest Products Research Laboratories of the Department of Scientific and Industrial Research, South Farnborough—The Secretary, The Department of Scientific and Industrial Research, 16 Old Queen Street, S.W. 1 (August 8). An evening lecturer in bacteriology at the Battersea Polytechnic—The Principal. A full-time lecturer for day and evening classes in engineering at the Erith Technical Institute—The Principal. A graduate master for physics and chemistry at the Andover Grammar School—The Director of Education, The Castle, Winchester. A lecturer in science, including biology, nature study or gardening at the Diocesan Training College, Ditchling Road, Brighton—The Principal.

NOVA PICTORIS.—*Astr. Nach.* 5379 contains an interesting note on this Nova by J. Hartmann, of the La Plata Observatory. The Nova had been under observation there from May 27 to June 5, during which time its brightness increased slowly, as the following table shows:

Mag.	Mag.	Mag.	Mag.
May 27. 2.8	May 29. 2.5	June 1. 2.1	June 4. 1.9
„ 28. 2.6	„ 30. 2.4	„ 2. 2.1	„ 5. 1.8

(Dr. Spencer Jones states that it afterwards attained the first magnitude.)

The increase of light has been more gradual and has lasted longer than in most Novæ; and the changes in the spectrum were also more gradual.

Hartmann obtained photographs with a small single prism spectrograph. These showed a continuous spectrum of the first type, with numerous strong absorption lines, of which the *H*, *K* calcium lines were the strongest, followed by those of hydrogen, helium, magnesium, etc. The hydrogen lines *H_β*, *H_γ*, and several other lines, showed a faint emission line on the less refrangible side of the absorption one. He, like Dr. Spencer Jones, holds out hopes that the somewhat unusual behaviour of this star may add materially to our knowledge of the nature of the processes that give rise to these outbursts.

It is interesting to note that Mr. Watson, who discovered this Nova, appears to have been the first to detect the outburst of Nova Aquilæ in 1918, so that he, like Mr. Anderson, has the record of two brilliant Novæ. It is fortunate that this Nova is circumpolar at the southern observatories, so that it will be possible to follow its decline without any break through the time of its conjunction with the sun.

Research Items.

CU-CHULAINN AND TOTEMISM—In *Man* for June, Dr. Géza Roheim, whose ingenious and suggestive psychoanalytic study of totemism in Australia has just been published in Great Britain, applies the same analytical method to the Cu-chulainn cycle of Irish legend with reference to its bearing upon the problem of totemic origins. Not only is the dog taboo of Cu-chulainn probably totemic, but also he becomes a dog by killing a dog. In other words, the legend contains more or less veiled references to the father-and-son conflict for the women of the Cyclopean family, from which, Freud holds, totemism and exogamy arose, of the animal symbol arising out of a feeling of guilt for the act of parricide, and of incest committed by the hero Cu-chulainn slays the dog of Cu-lain the smith, and serves in its stead, as other Aryan heroes served a term of apprenticeship with a smith, from whom they usually obtained their terrific weapon. But the smith and his dog are to be regarded as identical and the former represents the father. The slaying is therefore parricide. Cu-chulainn fights with and kills his own son, but Lugaid, who deals him his death-blow, is probably also his own son by an incestuous union, although ostensibly the son of Curoi. Curoi, the archaic form of the Oak King, is also to be regarded as the father of Cu-chulainn by whom he is killed. If then the smith is equated with his hound, the combat is between two heroes of the dog clan, and when Cu-chulainn breaks the taboo he is slain by his son Lugaid, a parallel being the case of the Baja King, who eats his totem animal when death at the hand of his son and heir draws near.

MORPHOLOGICAL DIFFERENTIATION OF BACILLUS TYPHOSUS—L. Nicholls and E. Burgess direct attention in the *Ceylon Journ. of Science*, Sect. D (Medical Sc.), vol. i pt 2, 1925, p. 47, to the discrepancies which occur in text-books between the sizes given in the text and the magnifications stated under the illustrations respecting certain micro-organisms. They believe that were more attention given to the accurate comparison of the size and morphology of different organisms, much help would be derived for purposes of differentiation and identification. As an example, they have compared the morphology of *B. typhosus* with that of 40 other bacilli isolated from water. The organisms were grown on three standard media: (1) ordinary nutrient agar, (2) salt (3 per cent) nutrient agar, and (3) salt-free peptone agar. Stained preparations were made and photographed under similar conditions. It was found that the *B. typhosus* could be distinguished almost at a glance from any one of these 40 water organisms by its characters when grown on these media. As regards the 40 water organisms, these corresponded morphologically to about 30 species, which agreed well with the results obtained by an extended series of culture and fermentation tests.

THE BRITISH FRESHWATER PEARL MUSSEL—Considering that it is still an article of economic value, although less so than formerly, it is remarkable how imperfect is our knowledge of the life-history of the British freshwater pearl mussel. What is known has been admirably summarised by Mr. J. Wilfrid Jackson, of the Manchester Museum, in the introduction to his address to the Conchological Society on "The distribution of *Margaritana margaritifera* in the British Isles" (*Journ. of Conch.*, 17, No. 7), a paper all the more valuable on account of the numerous references to original sources of information. The mollusc has a remarkably wide circumpolar distribution, and

exhibits persistent specific characters. Nevertheless, although the glochidial stage is known, the transitional stages between that and the adult are unknown and unrepresented in collections save for four young shells, in Mr. Jackson's own possession, coming from the River Conway. What the habitat of the young shells may be is at present a mystery (cf. Prof. A. E. Boycott in *NATURE*, August 23, 1924, p. 276). One would infer that they resort to deep water, since in shallow they would have been found long ere this. At the same time it should be observed, although not emphasised by Mr. Jackson, that these young shells might easily be mistaken for the juveniles of a species of *Unio*, because they are not black like the adult, nor do they exhibit the characteristic concavity of the ventral margin, whilst they are furnished with a complete set of hinge teeth similar to those of *Unio*. The assertion has been made by Dr. Haas that *Margaritana* (or, as it should be called, *Margaritifera*) is intolerant of hard water, and certainly it obviously shows a preference for soft waters, which makes it difficult to explain the markedly thick shells of the species. Prof. Boycott's appendix to Mr. Jackson's address, however, shows that this question evidently requires further investigation. A very full account of the distribution of the single British species, accompanied by a most instructive map, forms the conclusion rather than the bulk of the author's very valuable paper, to which we are glad to note there is to be a second part dealing with the past history of the mollusc.

RED CLOVER—Critical studies on the pollination, fertilisation, and breeding of red clover have led to conclusions of practical importance to agriculturists (R. D. Williams, Welsh Plant Breeding Station Publications, Series H, No. 4). Under ordinary conditions red clover is not self-fertilised, but a small number of plants are self-fertile if artificially self-pollinated, individual plants varying in the degree to which they are capable of this. The property of self-fertility is probably inheritable, and is greatly increased if pollination is effected before the flowers open, but so little seed is produced that it is doubtful if self-pollination can be of much practical use in the breeding of red clover. Humble bees are the chief agents in effecting cross-pollination at Aberystwyth and in Montgomeryshire, honey bees playing but a very small part. Six species of humble bees were observed on red clover, *B. agrorum* and *B. hortorum* being by far the most numerous and important, probably being responsible for 70 to 80 per cent of the total yield of clover seed in these districts. The seed yields are to some extent reduced by robber bees, *B. terrestris* and *B. lucorum*, and it is suggested that their depredations might be reduced by growing small areas of *Vicia villosa* near the clover, as this is a most attractive bait for these insects. As the bees are most abundant in early August, the yield of seed is much increased if the flowering of the clover is postponed until that time by means of judicious cutting of early strains or by growing late flowering strains. Larger yields might be obtained if more bees were available, and investigations are in hand with the view of increasing their numbers by judicious encouragement. Various methods of artificially breeding red clover have been tried, hand cross-pollination and controlled cross-pollination by humble bees being the two most promising methods of attack. Hand pollination is useless when many seeds are required or several plants are being intercrossed, but humble bees confined in various types of cages prove to be

very efficient agents, especially *B. agrorum*, *B. hortorum*, and *B. helferanus*.

PRODUCTION OF ALCOHOL FOR MOTOR FUEL IN THE TROPICS—The question of making an efficient motor fuel in the tropics, where imported spirit is expensive, is at present attracting considerable attention. Various materials have been suggested, and in some cases tried, as a source of power alcohol, such as starch-containing roots, and cellulosic residues from the sugar and other industries, but one of the most valuable appears to be the sap which may be collected from the flowering shoots of the Nipa palm of the Far East. Considerable work has been done in the Philippine Islands in ascertaining the suitability of this palm for the production of alcohol, and quite recently an experimental plant has been erected in the State of North Borneo. The plant is being run under the direction of the local Department of Agriculture, and an account of the results of the first year's working, based on a memorandum supplied by the British North Borneo Company, is given in the current issue of the *Bulletin of the Imperial Institute*, published by Mr. John Murray. There are about 300,000 acres of Nipa palm in North Borneo, occurring in nearly solid stands of 5000 acres or more. The sap flows for only six months in the year, but it is estimated that during this period 900,000,000 gallons of sap capable of producing nearly 60,000,000 gallons of alcohol could be obtained. The results of the first year's working of the experimental plant came up to expectations in every way. The still was only capable of producing 100 gallons of alcohol per working day of 12 hours, and the costs of running such a small plant were naturally somewhat high, but it is shown that a permanent plant producing not less than 1000 gallons per day should prove a commercial success.

FORMATION OF MALACHITE.—The May issue of the *Journal of the Chemical Society* contains a paper on the mechanism of the formation of malachite (2CuO , CO_2) from basic copper carbonate, by J. R. I. Hepburn. At ordinary temperatures the transformation appears to be caused through the intermediate agency of an aqueous solution of carbon dioxide or sodium hydrogen carbonate. In the former case normal malachite crystals are formed; in the latter, sphaerocrystals are produced, probably through crystal growth in a colloid medium (unchanged basic copper carbonate). Gelatin retards the change. The formation of malachite at 100° (by thermal decomposition of the blue solutions prepared by dissolving the basic carbonate in saturated sodium hydrogen carbonate) occurs as a surface film of interpenetrating sphaerocrystals, which is disrupted into individual crystals on further boiling. The direct cause of the change is attributed to loss of carbon dioxide from the sodium hydrogen carbonate at 100° with formation of the stable double salt Na_2CO_3 , NaHCO_3 , $2\text{H}_2\text{O}$ and malachite. Gelatin likewise retards this change.

THE SODIUM SPECTRUM—The July issue of the *Philosophical Magazine* contains a short communication from Prof. F. H. Newman, describing a successful attempt to obtain the spectral lines of sodium vapour due to changes of orbit involving less energy than that necessary for ionisation. The sodium vapour was contained in a triode tube of quartz maintained at 350°C . in an electric furnace. The electrons were supplied by a dull tungsten filament, and between the filament and the grid an increasing electromotive force was applied, the spectrum produced being photographed by means of a quartz spectrograph. After applying a correction of 0.4 volt to the observed potential to get the potential corresponding to the

energy with which the electrons pass through the grid, the author found that, in accordance with theory, at 2.2 volts the doublet 5896-90 only appeared, at 4.0 volts the doublet 3303-2, at 4.4 volts the doublet 6161-54, and at 4.6 volts the doublet 5688-3 appeared in addition.

MASS OF COMPOUNDS OF SILVER WHEN STRONGLY ILLUMINATED.—Messrs P. P. Koch and B. Kreis describe, in the *Zeitschrift für Physik* of May 16, measurements made on particles of silver bromide and silver chloride, the mass of which was about 10^{-11} gr. The particles were made to float in air in the electrostatic field of a condenser, in which they were observed by means of a microscope. The particles were strongly illuminated by means of an arc lamp and a powerful condenser; the mass being determined before and after illumination by means of measurements of the condenser voltage and of the charge of the suspended particle. The intensity of illumination employed was so high as 67×10^6 metre candles; and it was found that in a short time the loss of mass was so great as 25 per cent. This loss appears to be due to separation of the halogens. Silver iodide under the same conditions showed only very small alterations in mass. The apparatus may be regarded as a very sensitive microbalance, in which particles of the same order of size as those in a photographic plate can be weighed, and the theory of photographic action can be directly tested.

LOUD-SPEAKERS—The Marconiophone Co., Ltd., of Marconi House, Strand, now manufacture a loud-speaker which enables anyone to address an audience of many thousands and at the same time to be heard by equally large gatherings up to a distance of about 150 miles with the help of the Post Office land wires. The total equipment can be purchased outright or can be hired for 5*l.* per week. A powerful voice is no longer a necessity for a public speaker, and this ought to improve the quality of "orations" as the number of possible orators is largely increased. The distinguishing feature of the Marconi instrument is that it responds with equal sensitivity to all notes in the musical scale whether the sound originates 100 feet or 10 inches from its position. Recently a nightingale's song was broadcasted from the London broadcasting station, 2LO, by this device. The bird was singing about 100 feet away from the instrument, yet the song could be heard almost perfectly by broadcasting listeners. The apparatus has many points of difference from domestic loud-speakers. The construction is on the moving coil principle, and the diaphragm is of rubber and not of metal. As it has no natural or resonant frequency of its own, it is practically free from nasal defects, and there is no metallic timbre. The normal working range of one of these loud-speakers under reasonably silent conditions is approximately three-quarters of a mile.

SORPTION OF GASES BY GRAPHITE.—The sorption of oxygen by "activated" graphite forms the subject of a paper by D. H. Bangham and J. Stafford in the *Journal of the Chemical Society* for May. If s is the quantity of oxygen sorbed at time t after its introduction to the graphite, then the relation $s = kt^b$ holds, k and b being constants, both for ordinary graphite and for graphite containing hydrogen sorbed in a discharge tube. The results seem to indicate that the sorption of oxygen by ordinary graphite is due more or less directly to the hydrogen which it contained on manufacture. No water seems to be produced by the sorption of oxygen by graphite containing hydrogen; the sorbed gases may be pumped off as such.

The Nature of the Cell Membrane.

IS there a semi-permeable membrane to the cell? This question is examined by Prof L. Lapique in a review of very general interest which accompanies seven more technical contributions in animal, vegetable, or general physiology, in the first number of a new French journal, *Annales de Physiologie et de Physicochimie biologique* (Paris: Gaston Doin, annual subscription 45 francs outside France). The following, save for reference to some recent cognate American work, is based entirely upon Prof Lapique's stimulating and timely article.

Lapique admits at the outset that he finds the conception of a semi-permeable membrane around the cell a hindrance rather than a help in the interpretation of the behaviour of the cell, he therefore critically examines the case for such a membrane as presented by Bayliss in his great text-book. The idea of a membrane arises naturally when it is realised that protoplasm, though behaving in many ways as a protein sol, can frequently exist in contact with water without dispersing in colloidal solution throughout the aqueous medium. Clearly there is then a protoplasm water interface, and probably every one would agree that protoplasm at this interface has different properties from those characteristic of the main mass of protoplasm. Do these properties, however, necessarily include a different penetrability to solutes which justifies its distinction as a semi-permeable membrane enveloping a mass of readily permeable plasma? Even the advocates of the membrane will probably agree it is a phenomenon of the surface and that particles of protoplasm may lose and regain these surface characteristics as they leave or enter the surface layer. Certainly the ease with which the protoplasmic surface changes in amoeboid movement, leaving no collapsed membrane as the surface retracts, suggests that any change undergone as protoplasm enters the surface layer is reversible in nature. Whenever a permanent structural membrane can be identified at the surface of the cell, it is something distinct from the surface of the protoplasm, as is the cellulose wall of the plant, and is not the seat of any semi-permeable properties shown by the protoplast, so that in plasmolysis the plant protoplast withdraws itself inward from the permeable cellulose wall around it. The semi-permeable properties of the hypothetical membrane are usually interpreted as due to a sieve-like action. From this view-point no non-living semi-permeable membrane has been shown experimentally to be impermeable to molecules of less than about twenty atoms. The living membrane, however, is assumed to control the passage of inorganic ions. One may invoke the view that such ions move accompanied by a cluster of water molecules, but the fact remains that the non-living membranes fail to arrest their passage.

The distribution of ions upon either side of a semi-permeable membrane is now frequently attributed to the Donnan equilibrium, when a non-diffusible colloid on one side of the membrane forms ionisable salts with electrolytes. Consideration of the case of gelatin, however, shows that so long as the colloid is non-diffusible, no special membrane is required for the existence of a Donnan equilibrium.

Thus whilst for mathematical and physico-chemical argument the ideal semi-permeable membrane is a necessary concept, in experimental fact it has never been demonstrated, and there are considerable difficulties in assuming its existence. For example, botanists realise that inorganic salts must diffuse freely into the plant, and they interpret experimental observations of recovery from plasmolysis induced by external

concentrations of inorganic salts as evidence that such diffusion is occurring. On the other hand, present data as to the entry of salts, as summarised recently by Stiles in his monograph upon permeability, do not support the assumption that salts will diffuse through the plant protoplast until the ratio of salt concentrations in external solution and in the vacuole will be unity.

Bayliss argued that the resistance of the cell to the electric current, in view of its content in free electrolytes, could only be explained on the assumption of semi-permeability. Lapique points out that if this was the true explanation, the cell would behave as a condenser in an electric field, and that once the cell was fully polarised no more current would pass. Actually the high resistance may be explained equally well if protoplasm is regarded as a permeable but highly viscous medium.

Bayliss also stipulated the existence of a membrane on the following grounds: (1) In the presence of various electrolytes in solution the cell undergoes a permanent change in volume; (2) the electrolytes within and without the cell differ in kind and in concentration. Lapique deals with these arguments at some length. The change of volume of the vacuolated cell is admitted, but so also is the fact of recovery from plasmolysis, which shows that we are dealing with slow penetration of salts, not semi-permeability.

In any case this phenomenon is exhibited by the whole thickness of the cytoplasm, there is no evidence of the special rôle of a surface membrane. In the normal non-vacuolated animal cell, contraction of volume also takes place in the presence of salt solution, but this phenomenon cannot be attributed to the osmotic withdrawal of water from a non-existent vacuole, and is paralleled by the behaviour of gelatin and many other colloids, without superficial semi-permeable membranes, when placed in similar salt solutions.

As to the difference in kind and in degree of the concentration of salts within and without a membrane, all through the life of a human being the red blood corpuscles circulate in a medium rich in sodium and poor in potassium, and yet themselves remain rich in potassium and poor in sodium. To maintain this relative difference in concentration a membrane would surely need to be impermeable, but, as Moore and Roaf said in 1908, if such a membrane thus imprisons the salts and prevents adjustments of concentration, how did the salts enter the prison?

Lapique approves the general conclusion of Moore and Roaf that the ratio of concentrations of these ions within and without the living corpuscle depends upon a mobile equilibrium between cell constituents and surrounding liquid, and is not controlled by diffusion restricted by a semi-permeable membrane. Hamburger's experiments have shown these corpuscles to be very permeable to salts, so that any change in the medium produces an exchange of inorganic solutes between the corpuscles and the medium. Hamburger continues to regard the corpuscles as surrounded by a semi-permeable membrane, so that the loss of hæmoglobin in solutions hypotonic beyond a certain degree is explained as due to the bursting of the membrane. Lapique points out that these laked corpuscles still change in volume with change in salt concentration, just like the original red corpuscles, so that if the membrane is destroyed, some of the properties still remain which it was postulated to explain.

Hoagland and other American workers have recently provided in plant physiology equally puzzling data as to the distribution of inorganic ions within and

on passage through a prism and an object glass of a telescope, four partially superposed spectra, two of which can be exactly superposed. A slit at the focus of the telescope allows a portion of the three independent spectra to pass through, and the wavelengths transmitted may be adjusted suitably for compounding red, green, and blue lights. With weaker illumination the diffusion plate is omitted and a biprism is placed behind each half of the second split lens.—J. Forrest: A new method of discriminating the arrangement of the molecules in a crystal. High magnetic fields are used. Theory gives an estimate of the variations of the internal magnetic force in a crystal when the external magnetising field takes all possible orientations about the substance, which is regarded as composed of a regular array of molecular magnets. The components of force parallel and transverse to the field are dealt with, and positions of maxima and minima of these are predicted in any convenient plane of the crystal for any possible lattice arrangement of the centres. Some weakly magnetic crystals were investigated experimentally and give good agreement with the results of X-ray measurements. Different lattices can be compared with respect to their stability, dealing with the internal magnetic energy of regular arrangements of molecular magnets which are co-directed or randomly oriented.—D. A. Fairweather: The electrosynthesis of *n*-duotriacontane dicarboxylic acid. This acid, containing a chain of thirty-four carbon atoms, is the highest member of the series of normal dibasic acids so far prepared. Its di-ester was obtained by electrolysis of sodium ethyl hexadecane dicarboxylate.—W. L. Ferrar: On the cardinal function of interpolation theory. The relation of the series defining the function with other types of expansion is considered; in particular, its relation with the Gauss formula. The convergence of the latter implies the summability of the former (by de la Vallée Poussin's method) to the same sum.

PARIS.

Academy of Sciences, June 22.—G. Bigourdan: The systematic errors which may affect the pendulum corrections employed at the B. I. H.—V. Grignard and R. Escourrou: The catalytic hydrogenation of the nitriles under reduced pressure. A method for the synthesis of the aldimines. The activity of the catalyst is reduced by working under reduced pressure. With oxide of platinum on pumice as catalyst, at 200° C. and under a pressure of 220 mm, benzyl cyanide is completely reduced to the aldimine $C_6H_5CH_2-CH-NH$ at one passage. Benzonitrile undergoes a similar reduction.—C. Sauvageau: The naturalisation in France of the Australian *Asparagopsis armata*. Its iodine reserves. There would appear to be some free iodine in this plant.—Léon Guillet was elected a member of the division of the applications of science to industry in succession to the late Charles Rabut.—J. Haag: Certain asymptotic probabilities.—C. Valiron: Meromorphic functions which are exceptional relatively to the theorem of M. Julia.—V. Romanovsky: Certain mathematical expectations and on the mean error of the coefficient of correlation.—E. Huguenard, A. Magnan, and A. Planiol: A method of studying the inertia effects resulting from the operations of steering aeroplanes.—A. Lafay: The deviations of the thrust of the wind, on a cylinder, produced by a sheet of air impinging tangentially to the surface of this body.—F. Zerner: The entanglement of the ether and the aberration of the stars.—P. Chofardet: Observations of the Tempel II. comet (1925*d*, Stobbe)

made at the Besançon Observatory with the 33-cm. equatorial. Positions of the comet and comparison stars are given for June 15, 16, 18, 19. It was seen as a rounded nebulosity of about the 12th magnitude with a small central nucleus.—G. Rougier: Observations of the Tempel II. comet (1925*d*) made with the 49-cm equatorial of the Observatory of Strasbourg. Position given for June 16.—Mlle. Bérenger and A. Tian: Heats of solution and heats of incomplete reactions.—C. Gutton and E. Pierret: The harmonics of oscillators with very short waves.—G. Foex and L. Royer: The diamagnetism of nematic substances.—A. Dufour: The classical calculation of the Michelson experiment on the hypothesis of an immobile ether.—Mlle. J. Liquier: The variation of the rotatory power of solutions of asparagine as a function of the hydrogen ion concentration. Whatever acid be added the rotation is the same for a given hydrogen ion concentration. On the hypothesis that there is present a mixture of non-dissociated molecules and the corresponding ions, the rotatory power can be expressed quantitatively as a function of the hydrogen ion concentration and the two dissociation constants of asparagine. The theoretical curve so derived coincides closely with the experimental figures.—Th. Vautier: The secondary waves produced by an aerial wave.—Th. de Donder: The calculation of specific affinity.—Jean Barbaudy: The boiling-points of mixtures of water, benzene, and ethyl alcohol under a pressure of 760 mm. of mercury. The whole of the experimental results are shown on a triangular diagram. The minimum boiling-point given by Young is confirmed.—P. Chévenard: The dilatometric anomaly of the solid solutions of copper and aluminium.—T. Batuecas: Revision of the weight of the normal litre of methyl chloride gas. The methyl chloride was prepared by two independent methods, the interaction of phosphorus trichloride and methyl alcohol and by the pyrogenic decomposition of tetramethylammonium chloride. The mean of seventeen determinations is 2.3084, appreciably greater than the value given by G. Baume, 2.3045.—P. Job: The spectrographic study of the formation of mercuric complexes.—E. Rouyer: The association of the polyphenols.—J. Bardet and C. Toussaint: The separation of cerium, and the arc spectrum of this element. In the separation of zirconium and cerium a good method can be based on the difference of the solubility of the phosphates in sulphuric acid.—Pierre Auger: The experimental study of the directions of emission of the photoelectrons.—N. Delbart: Study of the corrosion of cold drawn steels in sulphuric acid of varying degrees of concentration.—J. Bougault: Phenyl- α -oxycrotonamide. An example of ether-oxide of the hydrate of a ketone.—Charles Dufraisse and Henri Moureu: Phenylbenzylglyoxal.—R. Weil: The microscopic study of the $\alpha\beta$ transformation of natural cristobalite.—Pierre Sève: An arrangement for measuring the optical constants of crystals in the ultra-violet.—L. Cayeux: The existence of diatoms in the millstone grit in the neighbourhood of Paris. The organic origin of the silica.—Ch. Maurain, E. Salles, and G. Gibault: The conductivity and electric currents of the atmosphere.—René Souèges: The embryogeny of the Rutaceæ. Development of the embryo in *Ruta graveolens*.—Ad. Davy de Virville: The action of light on the mosses. The appearance, size, colour, form, and structure of the mosses are modified by the intensity of the light to which they are exposed. With diminution or suppression of the light, the distinctive characters from which several species take their names disappear.—Mlle. France Gueylord and P. Portier: The ionic reaction

of the different constituents of the egg of the fowl. Its modifications in the course of incubation. In the early stages of incubation the white is alkaline ($P_n=8$) and the yolk is acid ($P_n=5.5$). In the course of development the reactions of the two constituents converge towards neutrality, which is reached on the tenth day—J. Nageotte. The morphology of striated muscle in a state of chloroform contraction, in the frog—E. Kayer and H. Delaval. Contribution to the clarification of apple musts—Naurice Nicloux and Jean Roche. The amount of oxygen in methæmoglobin. New experiments confirming the views of G. Quagliariello, that the oxygen in methæmoglobin is half that in oxyhæmoglobin.—C. Levaditi. The curative action of basic bismuth acetyloxyaminophenylarsinate in experimental syphilis. Stovarsol mixed with an aqueous solution of sodium and potassium bismutho-tartrate forms a new compound $(OH)(NH \cdot CO \cdot CH_3)_2C_6H_5 \cdot AsO_3H \cdot Bi(OH)_2$. In oil suspension this compound cures experimental syphilis in the rabbit—L. Fournier and A. Schwartz. The curative action of basic bismuth acetyloxyaminophenylarsinate in syphilis. An account of the treatment of twenty cases of syphilis with the compound described in the preceding communication. The injections cause none of the inconveniences usual with the ordinary bismuth treatment: the curative effect is as rapid as any of the best antisyphilitic preparations.

ROME

Royal Academy of the Lincei, April 19—Guido Fubini. The modular group in four-dimensional space—O. M. Corbino and E. Persico. The oscillating current diagram—N. Parravano and G. Malquori. Solubility of oxygen in silver. Absorption of oxygen by molten silver is very slow, and is complete only after some days. The velocity of absorption appears to be a function of the velocity with which the gas diffuses into the interior of the metal—Secondo Franchi. The great variety of the lithological complexes of the metamorphic Trias of the Western Alps—A. Carrelli. Tyndall's phenomenon—P. Bertolo. Genesis of artemisic acid from desmotropo-santonin—L. Fernandes. Co-ordination valency of two hydroxyl groups in the ortho position. I. Complexes of pyrocatechol and pyrogallol with acids of the molybdenum group—P. Leone. Metallo-organic compounds of aluminium. IV. Action of chlorides of acid radicles. The action of benzoyl chloride on aluminium ethyl iodide in ethereal solution yields $\alpha\alpha$ -dibenzoylthane, together with a very small proportion of propiophenone, ethane is also liberated, probably as a result of decomposition of the aluminium ethyl iodide by the hydrochloric acid formed during the condensation—G. Malquori. Thermal behaviour of hydrated barium aluminates. Barium aluminate, $BaAl_2O_4 \cdot 5H_2O$, prepared by dissolving the calculated amount of alumina in boiling saturated baryta solution, loses $3H_2O$ at 190° and $5H_2O$ at 310° , and shows breaks in the heating-curve at 725° and 1040° , corresponding with decompositions of the compound.—Carlo Sandonini. Certain physico-chemical properties of mixtures of water and acetone. The variation of surface tension, heat of mixing, specific heat, and viscosity of water-acetone mixtures with the composition renders probable the existence of complex molecules of the two compounds—E. Remotti. The immediate physical factors which may co-operate in determining the vertical migrations of fishes—Enrico Sereni. Certain peculiarities of the action of sodium chloride on the muscles of frogs.

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Official Publications Received.

- Report for 1924 on the Lancashire Sea Fisheries Laboratory at the University of Liverpool and the Sea-Fish Hatchery at Fockley. Edited by Prof. James Johnstone. Pp. 188 (Liverpool).
- Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Limited, Turner's Hill, Cheshunt, Herts. Tenth Annual Report, 1924. Pp. 104 (Cheshunt).
- Meteorological Office. Air Ministry Advisory Committee on Atmospheric Pollution. Report on Observations in the Year ending March 31st, 1924. Forming the Tenth Report of the Committee for the Investigation of Atmospheric Pollution (M.O. 270). Pp. 55 (London: H.M. Stationery Office). 4s. net.
- Annual Conference of the Universities of Great Britain and Ireland, 1925. Report of Proceedings. Pp. 40 (London: University Bureau of the British Empire). 1s.
- Conseil Permanent International pour l'Exploration de la Mer. Publications de Circunstancias No. 40. A Recording Current Meter. By H. J. Buchanan-Wollaston. Pp. 14. Publications de Circunstancias No. 57. L'emploi de la sonde normale dans l'océanographie. Par Martin Knudsen. Pp. 11 (Copenhagen: Andr. Fred. Høst & Søn).
- Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 43, Part 2, No. 21. Regeneration of the Aged Frog through Thyroid Medication. By F. A. E. Crew. Pp. 252-300. Vol. 45, Part 2, No. 22. L'entretien des pendules au moyen de cellules photoélectriques. Par M. le Général G. Ferrie. Pp. 261-265 (Edinburgh: R. Grant and Son, London: Williams and Norrington, Ltd.). 1s. each.
- Forestry Commission. Fifth Annual Report of the Forestry Commissioners, Year ending September 30th, 1924. Pp. 48 (London: H.M. Stationery Office). 1s. net.
- The Society for Promoting Scientific Knowledge. A Review of Activities during 25 years 1900-1925, and Twenty-fifth Annual Report. Pp. 46 (Lahore).
- United States Department of Agriculture. Department Bulletin No. 1323. The Flight Activities of the Honey Bee. By A. E. Lunde. Pp. 89. 10 cents. Department Bulletin No. 1331. Emulsion of Wormseed Oil and of Carbon Disulfide for destroying Larvae of the Japanese Beetle in the Roots of Perennial Plants. By U. R. Leach and J. F. Johnson. Pp. 18. 5 cents. (Washington: Government Printing Office).
- New South Wales. Department of Mines. Geological Survey. Bulletin No. 6. The Coal Resources of New South Wales. By the Staff of the Geological Survey. Pp. 134+12 plates. 2s. 6d. Bulletin No. 9. Limestone, Dolomite, Lime, and Hydraulic Cement. By Leo J. Jones. Pp. 37+7 plates. 2s. 6d. Bulletin No. 10. Barites, Ochres, and Oxides. By H. G. Ruggall. Pp. 16+2 plates. 1s. (Sydney: Alfred James Kent).
- Memoirs of the Indian Museum. Vol. 8, No. 2. Revision of the Indian Ampullariidae. By Dr. B. Prasad. Pp. 49+4 plates. 13-15 (Calcutta: Zoological Survey of India). 3 rupees.
- Aeronautical Research Committee. Reports and Memoranda, No. 20-21 (A. 178). Discontinuous Flow around the Edge of a Bluff Obstacle. By L. W. Bryant and D. H. Williams. (A. 1 b Photographic Work, etc., 9. -T 2008). Pp. 4+11 plates. (London: H.M. Stationery Office). 1s. net.
- Cornell University Agricultural Experiment Station. Memoirs of the Lepidoptera of New York and neighboring States: Primitive Forms, Microlepidoptera, Pyraloids, Bombyces. By William T. M. Forbes. Pp. 720 (Ithaca, N.Y.).
- Ministry of Agriculture, Egypt. Technical and Scientific Service. Bulletin No. 5. The Survival of Pink Boll Worm Larvae in Buried Seed during the Winter in Egypt. By C. B. Williams and Ibrahim Ed. Bishara. Pp. 7+2 plates. (Cairo: Government Publications Office). 5 P.T.
- Report of the Aeronautical Research Institute, Tokyo Imperial University. Vol. 1, No. 10. The Inertia Forces and Complex and then Balancing of the Star Type Engine. By Keiichi Tanaka. Pp. 247-304 (Tokyo: Maruzen Kabushiki-Kaisha). 1.10 yen.
- Field Museum of Natural History. Botanical Series, Vol. 4, No. 4. South American Plants, by J. Francis MacBride, also New Euphorbia, by C. F. Millspaugh, and Cannabins, by C. V. Piper. (Publication 241). Pp. 79-85 (Chicago).
- A Cotton Research Station for the British Empire. Being a Summary of a Report to the Empire Cotton Growing Corporation. By Prof. J. B. Farmer and L. G. Kilby. Pp. 25 (London: Empire Cotton Growing Corporation).
- The Faraday Society. Report of the Council and Statement of Accounts to be presented at the Annual General Meeting, July 6th, 1925. Pp. 11 (London: The Faraday Society).
- Smithsonian Miscellaneous Collections. Vol. 75, No. 3. Cambrian Geology and Palaeontology, V. No. 3. Cambrian and Ozarkian Trilobites. By Charles D. Walcott. (Publication 2624). Pp. 59-146+plates. 15-24 (Washington: Smithsonian Institution).

Diary of Societies.

SATURDAY, JULY 25

ARISTOTELIAN SOCIETY, MIND ASSOCIATION, AND OXFORD PHILOSOPHICAL SOCIETY (Joint Session) (at Balliol College, Oxford), at 10 A.M.—C. R. Morris, Dr. Dorothy Wrinch, and Prof. L. J. Russell. Symposium. The Concept of Energy.—At 2.30.—Dr. I. V. Mackenzie. The Biological Basis of the Sense of Time.—At 8.30.—Prof. J. A. Smith, Prof. A. D. Lindsay, and Dr. F. C. S. Schiller. Symposium. Croce's Theory of the Practical Nature of Science.

SUNDAY, JULY 26

ARISTOTELIAN SOCIETY, MIND ASSOCIATION, AND OXFORD PHILOSOPHICAL SOCIETY (Joint Session) (at Balliol College, Oxford), at 2.30.—P. E. More, Prof. W. D. Ross, and Prof. G. Dawes Hicks. Symposium. Plato and Aristotle.—At 6.30.—J. MacMurray, C. E. M. Joad, and A. H. Hannay. Symposium. Is Art a form of Expression or of Apprehension?

MONDAY, JULY 27.

CAMBRIDGE PHILOSOPHICAL SOCIETY, at 4.30

without the vacuolated cell. Using *Valonia* and *Nitella*, marine and fresh-water algae forms respectively, which have large enough cells to enable the sap to be collected from individual cells, they supply grounds for thinking that certain inorganic ions, for example potassium, are mainly, if not entirely, in solution in the sap of the vacuole, and yet retain a concentration much higher than that in the outside solution. The case of chlorides is particularly remarkable. *Nitella* will absorb practically every trace of chloride from the external solution, and will remain alive in distilled water for sixteen days without giving up any detectable trace of chlorine to the water, although containing very appreciable quantities in the vacuole. Hoagland concludes that *Nitella* under normal conditions possesses uni-directional permeability with reference to chlorine and potassium (*Journ Gen Physiology*, 5, pp 629-646, 1923).

Lapicque concludes that the simple doctrine of the semi-permeable membrane, as employed to explain the salt content and swelling properties of the living cell, will soon appear as inadequate as the astrological

conception of the firmament which makes it a crystal vault studded with stars. He adumbrates as factors, in a more adequate explanation, the distribution of salts according to the Donnan equilibrium between a non-diffusible amphoteric colloid and an aqueous membrane, with the great sensitiveness of such an equilibrium to hydrogen ion concentration, and also the hydrophilic behaviour of lipoids, which varies with the proportion of cholesterol to fatty acids or to lecithin. In view also of the modification reported in mitochondria with changes in external medium, he suggests that account may have to be taken of the physiological rôle of these structures, at present almost exclusively studied by the cytologist. Finally, he points out that the protoplasm is the seat of continuous transformation of energy, and that the phenomena under consideration will not admit of solution in terms of a passive semi-permeable membrane. To this last point the supporters of the membrane may reply that they have always assumed that a living cell owes its semi-permeable properties to a living membrane.

Maori Ethnography.¹

FOR more than half a century the New Zealand Institute has published in its Transactions a vast amount of valuable information upon all aspects of the history of a group of the most interesting islands in the world. In the earlier years of the Dominion few of the colonists were intimately acquainted with the native language, and fewer still could penetrate the veil that hides the thoughts and ideas of the Maori mind. Many of these ethnological contributions, therefore, are of doubtful reliability. They are, nevertheless, often quoted by anthropological writers in other countries who are unable to discriminate between the wheat and the chaff. After the New Zealand University, with its highly cultivated staffs in its various colleges, began to liberate on the colony graduates trained to careful observation and exposition, it was soon recognised that the scientific study of the native race was an undertaking of the utmost urgency, for the day was already far spent for the garnering of what remained of their rapidly vanishing traditions and beliefs.

New journals were therefore necessary for recording exclusively these anthropological data. The chief of these are the *Journal of the Polynesian Society*, the *Bulletins of the Dominion Museum*, and the *Records of the Canterbury and Dunedin Museums*. It is the tenth volume of the *Dominion Museum Bulletins*, by Mr. Elsdon Best, that now comes under notice. The author emphasises the qualifications with which any investigator of primitive peoples should be endowed. "No traveller," he says, "or he of short sojourns may delve into . . . the inner strata of the mentality of barbaric man . . . [The Maori] "ever closely shields his true religion" [and] . . . his inner mentality from the inquisitive gaze and analytical probing of inquiring outsiders . . . In order to open the pages of the inner life . . . of such folks it is highly necessary to gain his confidence. A long residence in their midst, a good knowledge of their language. A quiet and non-critical bearing, a heartfelt sympathy with the feelings and prejudices of the people."

Just such are the qualifications possessed by the author, and consequently he has attained to the position of one of the most trustworthy interpreters of Maori psychology, and one of the highest authorities on their customs and beliefs.

¹ *Maori Religion. Being an account of the Cosmogony, Anthropogeny, Religious Beliefs and Rites, Magic, and Folk-lore of the Maori Folk of New Zealand. Bulletin No. 10, Section 1. By Elsdon Best. (Dominion Museum, Wellington, N.Z., 1924.)*

The section of the Bulletin we have before us, a closely printed report of 264 pages, incorporates a vast amount of new and valuable, but not easily compressible, matter. It is impossible to do more than summarise its parts (as Mr. Best superscribes his chapters). An introductory part deals with the definition, origin, and development of religion preliminary to a comparison with Maori religion; the second surveys Maori religion and mythology from the evidence of early writers. On this follows a lengthy account of Maori cosmogony, theogeny, and anthropogeny, and further, by a classification of their gods, correcting the mistakes of several ethnologists who have misunderstood the term god as applied to the Maori religion. The New Zealand natives, above all the Polynesians of the Pacific, recognise a supreme divinity—Io—possessing divine attributes more nearly akin to the European idea of godhead. Part five deals with the offerings, human sacrifices, and images by which their spiritual beings can be influenced. This is succeeded by 28 specially interesting pages on the functions of the priests, the sacred places, and divination. Many ethnologists will read with surprise the singular fact that the village latrine was a *tuaha* or sacred place. *Tuaha* is the word "applied to any place where men's hair is cut, where tapu food is cast away or offered to supernatural beings," . . . and where "rites connected with many matters were conducted." The final part is concerned with an explanation of Maori ritual performances and formulæ—*karakia*—"a survey of native mentality and its effects as seen in the performance of rites connected with religion and magic," the numerous particulars of which "would require a chapter of cumbersome length." Mr. Best tells us, and so in the present Bulletin he can supply only a few illustrations. His work "The Maori," just about to be published, will, we hope, supply anthropologists with fuller details.

One suggestion may perhaps be permitted, that the numerous ritual formulæ quoted in the native language throughout the book and in several pages of addenda, might, if impossible of verbatim translation, be paraphrased to afford the reader, unacquainted with Maori speech, a general idea of their meaning. This monograph is of exceptional importance. So doubtless will be the second section, which will include a description of Maori magic and many illustrations of native myths and folk-tales.

University and Educational Intelligence.

ABERDEEN—At the summer graduation the honorary degree of LL D. was conferred on Dr. J. J. R. MacLeod, professor of physiology at the University of Toronto

The degree of D Sc. was obtained by R. S. Clark for a thesis entitled "Rays and Skates" and by W. O. Kermack for a thesis entitled "Investigations of the Synthesis and Reactions of Indole Compounds"

BELFAST—At the meeting of the Senate of the Queen's University held on July 15, a tender was accepted for the erection of buildings for the Department of Agriculture. It is hoped that these buildings will be completed in about 18 months at a cost of 46,000*l*. Of this sum, 34,500*l* has been given by the Ministry of Agriculture for Northern Ireland, 5000*l*. was contributed by the late Miss Riddell, and 6000*l*. was provided from general University funds.

Applications are invited from British subjects for the Musgrave research studentship in physiology, value 190*l*. Particulars and application forms are obtainable from the secretary of the Queen's University.

BIRMINGHAM—The following doctorates have been awarded: D.Sc.—W. E. Garner, for papers on gaseous explosions, heats of formation, detonation, crystallisation of organic substances, and other chemical subjects; J. D. Morgan, for papers on the ignition of explosive gases, and flame movements in gaseous explosions; and D. R. Nanji, for papers on chemical and biochemical subjects, mainly on the constitution of starch and the action of enzymes

CAMBRIDGE—Sir W. B. Hardy, Gonville and Caius College, and Dr. L. E. Shore, St. John's College, have been reappointed as University lecturers in physiology. Dr. E. K. Rideal, Trinity Hall, has been reappointed as Humphry Owen Jones lecturer in physical chemistry. The Wrenbury scholarship in economics has been awarded to H. C. B. Mynors, Corpus Christi College

The following have been appointed Henry P. Davison scholars for the year 1925–26: H. H. Thomas, Sidney Sussex College, to Yale University; W. P. N. Edwards, Corpus Christi College, to Princeton University; and G. R. C. Eley, Trinity College, to Harvard University

LONDON—The following doctorates have been conferred: D Sc (in Chemistry) on Mr. Samuel Glasstone (King's College), for a thesis entitled "Studies of Electrolytic Polarisation", and D Sc (Engineering) on Mr. R. G. Jakeman, for a thesis entitled "Alternating Current Wave-Windings," and other papers

The University Studentship in Physiology for 1925–1926, of the value of 50*l*. and tenable for one year in a Physiological Laboratory of the University or of a School of the University, has been awarded to Dr. Isaac Cohen, who proposes to carry out research on tetelin under the direction of Prof. E. C. Dodds at the Bland-Sutton Institute of Pathology at the Middlesex Hospital Medical School

The following are among the awards of the newly instituted University Postgraduate Studentships recently made: Travelling Studentships (value 275*l*) to Mr. Reginald Percy Austin and Miss Helga Sharpe Pearson. Mr. Austin proposes to study archaeology at the British School of Archaeology, Athens, and to undertake excavations. Miss Pearson obtained the M Sc degree in zoology in 1924 (University College). She proposes to work on early Tertiary mammals in the continental museums among which this material is scattered.

ST ANDREWS—Mr. S. R. Kirk, assistant in geology, and Mr. John Williamson, assistant in mathematics, have submitted their resignations on appointment to the new Commonwealth Fund Fellowships, under which British students are enabled to carry on research work for two years in the United States. Six out of the total number of twenty fellowships available in the first year of the institution of the scheme have been awarded to the University of St. Andrews

Principal John Yule Mackay has resigned the chair of anatomy in University College, Dundee, although he continues to hold office as Principal of the College

SHEFFIELD—The University Council has made the following appointments: Mr. I. C. F. Statham, to the chair of mining; Mr. N. M. H. Lightfoot, to be assistant lecturer in mathematics; Mr. Joseph Jenkins, to be assistant lecturer in civil engineering; Miss Esther Lowe, to be assistant in Zoological Department

The Busk Studentship in Aeronautics, founded in memory of Edward Teshmaker Busk, who lost his life in 1914 whilst flying an experimental aeroplane, has been awarded for the year 1925–26 to Mr. Stewart Scott Hall, of the Imperial College of Science, London

By the will of Sir Rickman Godlee, Bart., who died on April 20, the sum of 10,000*l* is bequeathed, after his wife's death, upon trust for investment, the income to provide travelling scholarships for students of University College Hospital Medical School, London, who have held a resident appointment in University College Hospital. The ultimate residue of the estate is to be divided equally between University College, London, and University College Hospital, unless the latter is taken over by a public authority, in which event the whole will go to University College

ROBERT BLAIR fellowships for this year have been awarded by the London County Council to Mr. N. P. Inglis and to Mr. A. B. Miller. The fellowships, which are worth 450*l* each, are for one year's study abroad. Mr. Inglis, who is a fellow in the University of Liverpool, proposes to continue his studies on the fatigue of metals. Mr. Miller proposes to investigate the metal construction of aircraft with special reference to the materials employed and method of production.

THE Ramsay Memorial Fellowship Trustees have made the following awards for the session 1925–26, the place at which research is to be carried out being indicated in brackets: British Fellowships of 300*l*. to Mr. G. A. Elliott for two years (University College, London), and to Dr. H. R. Ing for one year (University of Manchester); Glasgow Fellowships of 300*l*. to Mr. T. C. Mitchell for two years (University of Cambridge); to Mr. J. D. Fulton for one year (University of Manchester); Canadian Fellowship to Dr. D. McKay Morrison (University of Cambridge); Japanese Fellowship of the value of 370*l*. to Dr. Seis Takagi (University College, London). The following Fellowships have been renewed: Dr. S. W. Saunders (British Fellowship, University College, London); Mr. Kai J. Pedersen (Danish Fellowship, University of Bristol); M. M. Mathieu (French Fellowship, Davy Faraday Laboratory, Royal Institution, London); Dr. Nicolas Oeconomopoulos (Greek Fellowship, University College, London). Sir Robert Waley-Cohen has been appointed a Trustee of the Ramsay Memorial Fellowship Trust, in succession to the late Sir George Beilby

Early Science at Oxford.

July 28, 1685. Mr President presented ye Society with a Copy of his Algebra lately printed

A letter from Mr Aston dated July 23 was read, with it came Hevelius's *Annus Climactericus* presented to this Society by ye Royall Society

Four Mathematicall papers drawn up by Mr Tolet, were presented ye Society three of these papers were concerning gunnery, and ye finding altitudes the fourth mentioned a controversy between Mr Tolet and Mr Hern, concerning ye scituation of ye lines of Longitude, ye former affirming, that ye line of Longitude lies North and South, and ye line of Latitude East and West ye latter affirms that ye line of Longitude lies East and West, and ye line of Latitude North and South Concerning which controversy Mr Hern having appealed to ye Royal Society at London, and to this at Oxford for a determination, this Society on ye account of Mr Hern's appeal, and at the request of Mr Ash Secretary of ye Dublin Society gives their opinion, which is this, They conceive it has been generally received among mathematicians, that ye lines of Longitude ly North and South, and ye lines of Latitude East and West

These papers gave occasion to some discourse concerning the motion of Projecta, it was thought not improbable both by Mr President & Mr Caswell, that the Air does make a greater resistance against quicker bodies, than against those, which are slower, *ceteris paribus*

A Letter from Mr Cole of Bristoll dated July 18 and correcting a mistake in a former letter of his concerning ye measure of a Virginia Catskin in his custody, was read

A Letter from Mr Ash dated Trin Coll (Dublin) July ye 12th was communicated and read, it contain'd a letter of Sr R Buckley's, which gave a full description of ye new Calesh used by him this last letter is sent ye Royal Society

Dr Plot proved, that not onely Box of ye English woods sinks in water, for Elder, if you cut off ye pith & the rind, does ye same, as we saw, ye black Walnut of Virginia was seen to sink

The measure of the hand of a monstrous Irish man, shewn lately at Oxford, was communicated by Dr Plot, He was 7 foot 6 inches high, ye length of his span 14 inches, of his Cubit 2 foot 2 inches, of his Arm 3 foot 2 inches $\frac{1}{2}$, from ye shoulder to ye crown of his head 11 $\frac{1}{2}$ His name Edmund Melloon, aged 19 years Anno 1684, born at Port Leicester in Meath Upon this occasion Dr Plot discoursed on ye extravagant proportion of parts in men of an extraordinary size, especially after sickness concerning which he was desired to draw up his thoughts against ye next meeting

July 29, 1684. An Account was brought in, of ye Eclipse of ye Sun, on July 2, 1684, ye Observations were taken in ye University Observatory, by Dr Wallis, Mr Bernard, Mr Caswell, and Mr Rooke

Dr Plot presented ye Society with an Elf Arrow, brought from within two, or three, miles of Edinburgh, where they are in great plenty He shewed also some naturall gold of Scotland in a pepin, or great grain, and he also communicated an account of Black Lead found onely in Keswick in Cumberland, and there called Wadt, or Kellow

Mr Musgrave acquainted ye Society, that he had lately repeated ye experiment mentioned in ye Minutes of June 24th 1684, tying and cutting off, ye externall Jugulars of a dog, with ye same success as formerly, ye dog in neither of these experiments being any way concerned at ye stoppage of ye circulation in these veins

Societies and Academies.

LONDON

Geological Society, June 10—L R Cox The fauna of the basal shell-bed of the Portland Stone of the Isle of Portland On the western coast of the Isle of Portland the basal bed of the Portland Stone is a highly fossiliferous shelly limestone, on the surface of which fossils weather out in an extremely good state of preservation The specimens described were collected by Lieut-Col R H Cunnington and include about 80 species of mollusca, of which 18 lamelibranchs and 9 gastropods are new to science, and several others have not before been recorded from Great Britain—H L Hawkins Echinoidea from the Portland Stone and the Purbeck Beds. Before last year only one species (*"Echinobrissus" brodiei* Wright) was known from the Portland Stone A species of *Hemicidaris* from the sands was the only other echinoid recognised in the British Portlandian The work of Lieut-Col Cunnington has revealed three specimens of *"E" brodiei* in the basement-bed of the Portland Stone (and one from the overlying Whit-Bed), and material for the study of four other species, with indication of a sixth Prof Hawkins has also found *Hemicidaris purbeckensis* Forbes in the Middle Purbeck Series of Durlston Bay, near Swanage, which was collected from that locality about 75 years ago but not since, and specimens of an apparently new form referable to *"Pseudodiadema" sensu latissimo* The irregular distribution of echinoids in these and other Jurassic strata may be due to the known tendency of echinoids to live in restricted clusters (comprising several species of similar ecological quality), which seem to migrate wholesale in successive generations—E Spencer On some occurrences of spherulitic siderite and other carbonates in sediments The spherulites occur in association with fine-grained sediments of carbonaceous, muddy, or silty type, often with comminuted plant-tissue, and are fairly uniform in size locally The deposits seem to be of freshwater origin and devoid of calcareous shelly remains, the carbonate material in most cases consists of nearly pure siderite The occluded sediment is similar to that in which the spherulites are embedded; where "zoning" of the sediment occurs, it is subordinate to radial structure The spherulites probably formed from iron-carbonate solutions held within the gradually settling and consolidating sediment The reactions resulting from the presence in sediments of humate compounds, salt, calcium carbonate, etc., are considered The iron compounds present in solution in fresh water were probably adsorbed by the fine-grained and partly colloidal sediments, and carried down with them during deposition Super-saturation would result from the settling and flocculation of the sediment, and from the gradual upward expulsion of the more readily diffused water-molecules Crystallisation would then commence at a number of centres simultaneously

Optical Society, June 11—E F Fincham: The changes in the form of the crystalline lens in accommodation. According to Helmholtz, the lens swells and increases in convexity during accommodation because the tension upon it is relaxed when the ciliary muscle contracts In order to explain the change of the anterior surface of the lens to a hyperbolic form in accommodation, Tscherning states that the tension of the lens is maintained when the muscle contracts, and the forms of the surfaces are altered by a pressure by the vitreous humour exerted

upon the periphery of the posterior lens surface. The radii of curvature of both anterior and posterior surfaces of the lens, and also the movement which the apices of these surfaces make in accommodation, have now been measured. In two selected cases of men of the same age and having the same refractive error, considerable differences in the behaviour of the lens in accommodation were found. For a given amount of accommodation, whereas the lens surfaces in one case are more increased in curvature than in the other, their apices suffer less movement; the surface which was most altered in curvature showed the most pronounced hyperbolic form in both relaxed and accommodated conditions. The results can be explained by the Helmholtz theory, by taking into account the properties of the lens capsule.—**C. V. Raman and K. Banerji**: The optical properties of amethyst quartz. A section-plate of amethyst cut normal to the optic axis, when viewed under suitable conditions, without a polariser or analyser, shows coloured diffraction fringes of the Fresnel type, arranged periodically and running parallel to the lines of the structure. The diffraction effect is due to the periodic change of phase produced by the structure and not to any periodic variation of transparency. The diffraction spectra of the Fraunhofer type due to the structure may also be observed. The plate is thus in effect a phase-change diffraction grating.—**R. S. Clay and T. H. Court**: A Lucernal microscope by Samuel Washbourn, London. The instrument, which was probably made in 1800, has adjustments for focussing and for moving the object in two directions at right angles to one another. The objectives, consisting of single lenses, are mounted in a vertical slide so that different powers may be used. All the adjustments can be made from the eyepiece end. The instrument can readily be taken to pieces and the parts fit into a case, suggesting that it was originally used by a peripatetic lecturer.

Physical Society, June 12.—**G. Temple**: On mass and energy. It is assumed that variations in the potential energy of a body (gravitational or electrostatic) are always accompanied by proportionate changes in its mass. Continuing this assumption with the theories of Newtonian dynamics and Maxwellian electrodynamics, it has been found possible to predict all those phenomena, which are usually regarded as the crucial tests of the theories of relativity, both "special" and "general".—**E. Tyler and E. G. Richardson**: The characteristic curves of liquid jets. Continuing the work of S. W. J. Smith and H. Moss upon the relation between the length of a capillary jet and its velocity of efflux from a cylindrical orifice, further examination has been made of the causes to which the main features of the curves obtained by these authors are due. Such curves consist of two main branches. In the first, with increasing velocity, the jet length rises until a critical point is reached. In the second, which begins at this point, the jet length diminishes rapidly with further increase of velocity. The results now obtained indicate that, while surface tension is of prime importance in the first parts of these curves, viscosity is the dominating factor in the second.

Royal Statistical Society, June 16.—**F. Shirras**: Taxable capacity and the burden of taxation and public debt. The national income of Great Britain and Northern Ireland in 1924 is estimated at 3850 millions sterling. At the end of 1919 it was between 4000 and 5000 millions sterling. The national income of France for 1924 is estimated at 164 milliard

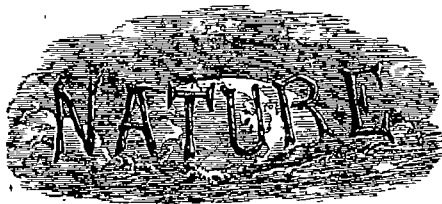
francs; of Germany, for the end of 1924, at least 30 milliards of gold marks; of the United States in 1924, 60,000 million dollars. Taking the percentage of taxation to the total net income the following figures are for 1923 or 1924, those in brackets being the pre-War year figures: Germany, 26 per cent. (11.8 per cent.); Great Britain and Northern Ireland, 22.1 (11.4); Japan, 21.8 (18.2); Canada, 19.2 (13); Australia, 18.4 (10.4); France, 17.8 (13.8); Austria, pre-War, 15 per cent., and the 1924 figure indicates that taxation is probably heavier than before the War; United States, 10.5 (6.5); and India, 5.1 (4.4).

DUBLIN.

Royal Irish Academy, June 8.—**J. J. Nolan and J. Enright**: Preliminary account of observations on the size of raindrops. Raindrops of radii from 2 to 45×10^{-3} cm have been accurately measured. This range covers the interval between the observations of Defant on raindrops and those of Köhler on mist-particles. The smaller drops are found in very great numbers. Certain sizes appear to be specially prominent, but further observations are necessary to test the reality of this prominence.

EDINBURGH.

Royal Society, June 8.—**Sir Alfred Ewing**: A ball and tube flow-meter. The device provides a visible measure of the rate of flow of a liquid through any pipe system without interfering with the flow. It consists of a slightly tapered, straight glass tube to which a scale is attached. Within the tube is a ball which is a loose fit at the bottom, and round which there is a considerable clearance as the ball is forced up in the tube. The tube is placed in a sloping position with the narrow end down, and the liquid flows up towards the wider end. The stream carries the ball up along the tube until a position is reached where the clearance round the ball is such as to suit the particular rate of flow. The position of the ball is read off on the scale, and from that position the rate of flow is determined. The sustaining action of the moving stream upon the ball is due to two causes: an inertia effect caused by the development of turbulence in the region above the ball, and an effect of viscosity by which the stream produces an upward drag in passing over the ball. By experiments with two fluids the relative magnitude of the two effects was determined. The device is being adapted by the Engineering Committee of the Food Investigation Board to indicate the circulation of the working fluid in the cycle of a refrigerating machine.—**Général Ferrié**: Maintenance of clocks by means of photoelectric cells. The pendulum to be maintained in oscillation is mechanically entirely free. A small mirror is attached near the top of the rod and a permanent horseshoe magnet to the foot. Light falling on the mirror is reflected in the vertical position of the pendulum to a photoelectric cell. The electron current is amplified, and passes round a solenoid which engages one arm of the horseshoe magnet attached to the pendulum in a suitable position, and maintains the motion. Complete syntony is thus realised.—**W. Peddie**: A spectrometer designed specially for investigations regarding colour vision. A single slit is used and the collimator lens, being divided into halves diametrically, gives two images which are formed on a diffusion plate and so act as the two slits with a single source. A second split lens parallelises the light from these images and gives, by suitable sliding of the halves,



SATURDAY, AUGUST 1, 1925.

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The Future of the British Patent Office.

II.

IN investigating in Great Britain the novelty of an invention, the Patent Office confines its search to British specifications published within the previous fifty years, and we have suggested that the search should be extended to cover text-books, periodicals, and foreign specifications, the period of search being restricted to twenty years except in the case of British specifications and text-books. The foreign specifications to be considered would be those published in the Dominions, France, Belgium, Germany, the United States, and Switzerland, for few inventions of serious importance will fail to be protected in one or other of these countries. We have now to estimate the increase of staff and of cost which this innovation would involve, and to show that the expense can be met by practicable means.

The machinery for the present search amongst British specifications was evolved by the scientific section of the Patent Office staff after many trials, and its success suggests that the devising of extended machinery must be left in the same hands. In order, however, to estimate what is involved in the present proposals, it will be necessary to consider in outline the form which that machinery would probably take. The characteristic feature to which the British search owes its thoroughness is the use of abridgments, so that the first step would be the abridging of the specifications published within the prescribed period in the countries we have mentioned, with the exception of New Zealand, Australia, and Belgium, for which countries abridgments are already available. Since the same inventor will often protect his invention in several different countries, many duplicates will be found: in order to sort these out and bring them together, by the aid of the inventor's name, the title, and the general aspect of the drawings, a small clerical staff would be necessary. For the actual work of abridging specifications in French and German the use of translators is to be deprecated, for it is both uneconomical and unsatisfactory in its results. Each class of subject-matter should preferably be indexed and abridged by the examiner, or syndicate of examiners, familiar with that class, so that it will be necessary for each syndicate to contain some one familiar with French and German. This should not be difficult, since most scientific men already know at least one of these languages.

As regards literature, text-books and year-books present little difficulty as they are usually provided with indexes, and examiners would soon become familiar with those which relate to their particular classes. Weekly and monthly periodicals and irregular publications such as bulletins are, with few exceptions, devoted

to a very restricted range of subject-matter: the examiner concerned with any such periodical would make extracts from it for his card index, the shorter extracts by means of manuscript notes and the longer extracts by means of underlined press-cuttings. The more general periodicals would have to be circulated to a number of examiners, but in most cases it would be sufficient to arrange that a single primary examiner should read each issue, passing on to the appropriate colleague any subject-matter for which he could not himself account satisfactorily.

We have now to estimate the increase in staff which would be necessary in order to carry out a search of the extent and thoroughness proposed. Let us consider first the state of things which will prevail when all preparatory work has been completed and only current work is being dealt with. We must compare the work of dealing with the specifications published annually in the countries we have mentioned with the annual work done on British specifications by the present staff, and for this purpose we shall assume that an examiner spends one-fifth of his time in abridging and indexing, one-fifth in actually searching, and the remaining three-fifths in general examination, attending to amendments, interviews, and provisional specifications, preparing for hearings, improving the classification of search material, studying law reports and technical literature, and other miscellaneous duties. We shall assume further that the time spent in reading, indexing, and abridging a specification would be halved in the case of foreign specifications, for since no general examination is to follow in their case, a far less meticulous reading would suffice than in the case of British applications; and we shall assume that the rate of searching could be increased by increasing the number of sub-headings under which inventions are classified. There are no statistics to support these assumptions and they are open to debate, but it can be said in their favour that they appear reasonable, and further, that the actual time spent in these tasks can be controlled, since the standard of thoroughness is necessarily somewhat arbitrary.

These assumptions, then, give us a measure of the additional staff necessary to abridge, index, and search through a given number of additional specifications, and we must turn next to the statistics of specifications published abroad. In doing so, however, we must allow for duplicates, for (to give only two examples) 65 per cent. of Canadian patents are granted to residents in the United States, 7 per cent. to residents in Great Britain, and only 16 per cent. to Canadians: while of British patents 58.5 per cent. are indigenous, 28.5 per cent. are granted to residents in the other countries we have mentioned, and the remaining 13 per cent. are granted to residents in Sweden, Holland, and other

countries not mentioned. (These figures relate to the year 1922.) It is safe to assume that every applicant will have applied for a patent in his own country, so that in estimating the number of foreign specifications per annum we may eliminate duplicates by counting only indigenous patents. The resulting figure will be a little too small, but sufficiently accurate for our present purpose. The latest complete statistics are for the years 1921 and 1922, and taking the mean of these two years as a basis, the annual output of unabridged indigenous published specifications is as follows: Canada 1610, South Africa (estimated) 340, India 263, France 10,394, Germany (estimated) 14,500, United States 33,941, Switzerland 1907, total 62,955. This total we must compare with the mean number of specifications abridged annually by the present examining staff during the same period. This figure is not accurately known, as not all specifications which have been abridged are published, but it cannot be far short of 19,000. At this rate the new material to be abridged annually will be about 3.3 times the material at present abridged annually, so that on the basis already explained we must increase the staff by 33 per cent. on this account.

New Zealand publishes about 360 indigenous patents per annum, Australia 2600, and Belgium 6000, but as these are already abridged the work of indexing them, at the rate of about 1 per fortnight per examiner, need not be taken into account. As regards the time spent in searching amongst foreign patents, the search material would be increased by the specifications published in the countries mentioned during the previous twenty years, the total being about 1,750,000, but to allow for duplicates this must be reduced, in the general ratio of indigenous to total patents, to 1,250,000. The latter figure must be compared with the number of British patents at present in the search files and covering a period of fifty years: that number is about 550,000, so that the search material will be increased by about 228 per cent., and on the basis we have adopted this means a further increase of 23 per cent. in staff to allow for the extra time spent in searching.

As regards literature, we pass over text-books and year-books because, as has already been pointed out, the staff can take these in its stride. Of the 1759 weekly, monthly, and irregular periodicals taken by the Patent Office Library, a considerable proportion is devoted to non-patentable subject-matter. Of those which contain search material it has been estimated that there are very roughly 18,000 issues per annum, a number of the same order as the number of British specifications filed per annum. To determine the average content of an issue would require a very elaborate research, for some periodicals, such as papers on wireless, contain a good deal of subject-matter, while others, such as agricultural

papers, rarely contain any reference to invention, and mere quotations from specifications could, of course, be ignored. On the whole, we shall be fairly safe if we say that one average issue contains as much subject-matter as one average specification, and at this rate we must allow a further increase in staff of 10 per cent. on account of indexing periodicals and 7 per cent. on account of searching them for the past twenty years. This gives a total increase of 73 per cent. in the staff, if we make no allowance for time to be spent in visiting factories.

We turn next to the preparatory period which must elapse before a universal search could be undertaken. The preparatory work would include (1) the improvement of the classification by increasing the number of headings; (2) the training of the new staff and reorganisation of the staff as a whole; (3) the abridging and indexing of the periodicals and foreign specifications published during past years. The last item is the most serious, and is the only one which we shall take into consideration here. If merely the additional 73 per cent. of staff were to be engaged some time before the institution of the search for the purpose of carrying out the work of preparation, there would be a delay of 12 years before the search could begin; so that in addition to increasing the establishment by 73 per cent. it would be necessary, in order to shorten this delay, to engage a temporary excess of, say, 23 per cent. of the then establishment. This would enable a search to be begun five years after the engagement of the new staff and covering a period of thirteen years: three and a half years later the full period of twenty years could be searched, and there would then be a redundant staff of 23 per cent., which would be absorbed by normal wastage in six or seven years. If a larger excess staff were engaged in the first instance the search could be undertaken at still shorter notice, but the capital cost would, of course, be increased. Against this capital cost must be set off, in any case, the saving due to the fact that the new staff would enter the office on the lowest rung of their salary scale.

Great Britain is spending some 466,000,000*l.* in the relief of unemployment, largely by methods admittedly uneconomic. Little is being spent in the relief of unemployment by the stimulation of new manufactures: on the contrary, the inventor has to pay for the whole cost of the patent system and to pay upwards of 75,000*l.* a year in addition, in relief of general taxation, whereas in 1924, the United States thought it worth while to spend on her patent office 408,602 dollars out of her exchequer. These facts must be borne in mind in considering the question of the annual cost of the proposed extended search. The chief item will be the annual salaries of the additional staff, and we must estimate these not at the initial rate of salary

at which new entrants will take up their duties, but at the average taken over their whole official career, which will be considerably higher. We may assume that this average will be equal to that for the present examining staff, so that if we take the aggregate salary of the latter, excluding Hearing Officers, and multiply it by 0.73, we shall arrive at the normal increase in annual expenditure on this account. The result, as estimated from the Comptroller's Report for 1924, amounts roughly to 106,400*l.* per annum, and to this we may add 3000*l.* for clerical and other supplementary staff, 5000*l.* for purchase of documents, and 7000*l.* for buildings, furniture, and maintenance, giving a total of 121,400*l.* per annum.

How is this additional expenditure to be met? We may put aside for the moment the suggestion that the whole cost of the patent system might be transferred to a tax on the sale of patented articles, and turn to more conventional sources of revenue. In the first place, the Patent Office makes a profit of 75,000*l.* a year. There is no justification whatever for this profit: it is a direct tax for the discouragement of invention, and only persists because it has been no one's business to attack it effectively. We may assume, then, that this profit can be abandoned, as the community's contribution to the cost of a scheme which is to benefit it considerably. Next, the maximum normal life of a patent might be extended to twenty years instead of the present sixteen. For the older patents the yield from renewal fees in respect of the n th year is given in pounds sterling by the formula $1.7 \times 10^{5-0.072n}$ with such accuracy that we may venture to extrapolate for the four years following. We thus find an additional yield of 32,000*l.* per annum from this source, leaving 14,400*l.* still to be found. As some 17,000 patents are sealed per annum, the addition of 1*l.* to the sealing fee is consequently the only increase in fees which would be necessary in order to balance the Patent Office budget.

In order to justify the preceding calculations it is necessary to examine rather carefully the effect of an increase in fees on the annual output of inventions. It may be supposed that such an increase will tend to diminish the output of inventions, while the enhanced value of the patent when granted will tend to augment it, so that some doubt arises as to the net effect. All experience goes to show, however, that a small change in fees has a negligible effect. When the present very limited British search was introduced in 1905 and at the same time the sealing fee of 1*l.* was added to the cost of the British patent, no change at all took place in the annual number of applications, while, on comparing the triennium 1902-4 with the triennium 1906-8, we find that the annual number of complete specifications increased by 17.5 per cent., and the annual number of

patents sealed increased by 6 per cent. In the United States the application fee was increased in 1922 from 15 dollars to 20 dollars, the final fee of 20 dollars remaining unchanged and no *quid pro quo* being offered by way of increased value in the patent: yet if we compare the preceding years 1919-21 with the following years 1923-4, we find that before the change the United States had 2.54 times as many applications as Great Britain, and after the change 2.50 times as many, a drop of only 1.6 per cent.

Then again, the scales of fees are very different in Great Britain, Germany, and the United States; yet the output of inventions per head of the population is roughly the same in each of these countries. Thus in Great Britain there is an application fee of 1*l.*, a "complete" fee of 3*l.*, and a sealing fee of 1*l.*, or a total initial fee of 5*l.*, followed by an increasing scale of renewal fees for the fifth and later years. In Germany there was until recently an application fee of 6 gold marks and an examination fee of 8 gold marks, or a total initial fee of 14 gold marks (about 14*s.*), followed by an increasing scale of renewal fees from the second year onwards. In the United States there is an application fee of 20 dollars and a final fee of 20 dollars, or a total of 40 dollars (8*l.*), but there are no renewal fees at all. It might be expected, therefore, that the output of specifications would be very different in the three countries, yet if we take the official figures on this subject for the year 1923 and compare them with the populations as given in the latest Whitaker's Almanack, we find the following result: Applications per thousand of the population in Great Britain, 0.69; in Germany, 0.75; in the United States, 0.76. Complete specifications filed per thousand of the population in Great Britain, 0.40; in Germany, 0.38; in the United States, 0.39. All these figures go to show that within reasonable limits fees have very little effect on the output of inventions.

Mr. Churchill has said that an overwhelming case can always be made out for doing nothing. To institute an extended search such as we have described would be a large undertaking, and one which is sure to encounter the opposition of a good deal of natural inertia. Yet at the present time the British patent system is like an unfinished house, and if the figures we have given are of the right order, there is no serious reason why it should not be provided with its roof. We have shown that if a substantially universal search be undertaken within five years, the Patent Office can still balance its annual budget without increase of fees, except for the addition of 1*l.* to the sealing fee. It is for those who would benefit by the institution of such an extended search to press upon the Government the importance of this method of stimulating invention and industry.

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Technical Problems of the Painter's Art.

Papers of the Society of Mural Decorators and Painters in Tempera. Second volume, 1907-1924. Edited by John D. Batten. Pp. v+134+6 plates. (Brighton: Printed for the Society by the Dolphin Press, 1925.) 10*s.* 6*d.*

THE Society of Mural Decorators and Painters in Tempera is to be congratulated on having produced a volume of fascinating interest to those who are intrigued by the practical problems of the painter. The trouble is that it suggests so many queries, criticisms, and comments and opens up so many lines of inquiry that it requires a volume rather than a brief article for adequate treatment.

The painter of pictures and of wall decorations of to-day is in the unfortunate position of having lost invaluable studio traditions and having to rely on obscure and doubtful records of old methods of painting. The Tempera Society is, therefore, on the right lines in trying to bring together the experience of the painter, the information to be obtained from ancient records and the critical examination of old pictures, and in addition, the knowledge of the man of science. When all this has been done, the difficulty remains that there are many problems that can be solved only by the study of the slow but inevitable action of oxygen, of moisture, of light, and possible internal changes in the materials themselves through long periods of time.

All the publications in this volume are not new to those who are closely in touch with the subject, but they are none the worse for being reprinted, the papers by Mr. Neol Heaton on the frescoes at Knossos and by the late Sir George Beilby on lime putty being of special interest. Mr. Tudor Hart is also to be congratulated on his excellent recipes for preparing egg and size emulsions. He has had much experience in the use of these mediums. The systematic and scientific study of emulsions which is at present in progress in many laboratories must ultimately prove of the utmost value to the painter in the egg or tempera medium, and the modifications of it produced by the addition of drying oils and varnishes.

There are two urgent problems before the painter to-day. One is the problem of wall decoration under modern conditions of air laden with coal smoke and oxidation products of sulphur dioxide. It is admitted that painting with selected pigments mixed with water on wet lime has proved the most permanent method of wall decoration under suitable conditions, and it has an æsthetic value which is not obtainable by an oily medium no matter how much the oiliness of oil is suppressed by the addition of wax; but it

is obviously peculiarly liable to attack and injury under the atmospheric conditions existing in our modern cities, and it is at any rate open to question whether the northern tradition was not in favour of the use of oil, as shown by the early records of the purchase of painting materials both at Westminster and Ely. Mr. Tristram, who has been cleaning the tombs at Westminster, gives his verdict in favour of size either emulsified with or afterwards varnished with oil. I had the opportunity of examining some tiny samples from the Westminster tombs and can confirm the presence of oil, which shows that in the north there was no objection to an oil effect on decorated stone. I also found azurite, the native copper carbonate blue, and in that connexion a curious technique, namely, a layer of white lead in oil next the stone covered with a gesso containing vegetable fibre, suggesting that it was considered necessary to protect the azurite from any possibility of damp coming from the stone.

I am disposed to think we should boldly accept an oil technique for wall decorations under modern conditions. Where Buon Fresco can be used safely, it is supreme; and if we ultimately adopt scientific methods of heating, its revival should be possible even in the cities of this country. But even in this technique there are still unsolved problems. Pliny and Sir Arthur Church both agree in throwing doubt upon the use of certain yellow ochres in Buon Fresco. Mr. Burton suggests Perigord Ochre, but further inquiry and research are necessary.

The other problem facing the painter to-day is the correct use of the oil medium in the painting of pictures. Artists complain of premature cracking which occasionally occurs, and more generally of a lowering of tone from which some painters suffer much more than others. The Tempera Society in its return to the egg medium of the Italian painters of the thirteenth, fourteenth, and fifteenth centuries, represents a revolt from oil, which, owing to its facile easiness as a medium, leads to reckless use and consequent trouble.

The researches of Prof. Eibner, of Munich, have done much to put us on the right lines for solving the problem of cracking. The lowering of tone is due to the neglect of the study of the optical properties of the dry oil film of increasing age, and the reaction of these optical changes on the optical properties of the pigments. When we possess as complete a knowledge and mastery of the optical as well as of the chemical properties of the oil mediums as was possessed by Van Eyck and his followers, we shall find the solution to both these problems.

By a return to the combined tempera and oil technique, along with a thorough understanding of

the optical properties of the oil film and its effect on pigments, and the obtaining in addition of a reliable backing for our pictures, better than canvas primed in the usual way, will be found, I hope, a way out of our difficulties.

In the meantime, all praise to the Tempera Society for its courageous attack on these problems. My only criticism is that they are not availing themselves sufficiently of the services of the chemist. The excellent work done, as revealed in this publication, by Burton, Noel Heaton, and Beilby, shows how much more we could do in the way of advice, criticism, and caution, and we are all anxious and willing to help.

The Society has already widened its remit so as to include wall decoration. Might not room also be found for the contemned oil medium?

A. P. LAURIE.

Geophysics in France.

Traité d'électricité atmosphérique et tellurique. Publié sous la direction de E. Mathias par J. Bosler, Dr. P. Loisel, Prof. R. Dongier, Prof. Ch. Maurain, G. Girousse, Prof. R. Mesny. (Comité Française de Géodésie et de Géophysique: Publications de la 6^e Section.) Pp. xx+580. (Paris: Les Presses universitaires de France, 1924.) 40 francs.

THE U.G.G.I. (Union Geodétique et Géophysique Internationale) is a post-War body which meets normally once in three years, and has for its props and feeders national committees of geodesy and geophysics in the countries which give their financial support. The Union is subdivided into sections, of which one known as T.M. and E. deals with terrestrial magnetism and electricity. The French national committee, being a business-like body, has corresponding sections, each apparently with its president and secretary. The section answering to T.M. and E. is known as No. 6. Its president is M. D. Berthelot, membre de l'Institut, and its secretary Prof. E. Mathias, director of Puy de Dôme Observatory. The president contributes an eloquent preface of seven pages to the volume. He explains that it represents a labour undertaken by the section at the suggestion of Prof. Mathias. The completion of so comprehensive a treatise would, as he says, require enormous labour and profound erudition on the part of any one man, and during the years required to write it fresh knowledge would accumulate. Common sense thus dictated co-operation, and in M. Berthelot's words, "Une pléiade de spécialistes distingués ont bien voulu nous prêter leur bienveillant et désintéressé concours." The general arrangement and supervision fell to Prof. Mathias, whose devotion

to his self-imposed labours merits all respect. The production of such a work must have been costly. It is thus interesting to note that a subvention was received from the Caisse des Recherches Scientifiques, the president of which is M. A. Lacroix, permanent secretary of the Academy of Sciences. An enumeration of the several authors and their contributions will give, it is hoped, some idea of the wide compass of the volume.

Prof. R. Dongier treats of the earth's electric field, the instruments used in measuring it and the results obtained. In a short note later in the volume, he discusses the theory of the quadrant electrometer. Prof. C. Maurain, Director of the Geophysical Institute, Paris, writes on loss of charge, ionisation and conductivity of the atmosphere, and on atmospheric currents and conduction. Dr. P. Loisel discusses radio-activity of the air, with subsections on the radio-activity of the earth and of wells, and he treats of the relations of radio-active substances to the earth's internal heat. Prof. R. Mesny deals with radio-telegraphy and atmospheric. M. J. Bosler, Director of Marseilles Observatory, discusses earth currents (of natural origin). M. G. Girousse, Director of Triphasé (Nord-Lumière), deals with earth currents of artificial origin.

The longest contribution, by Prof. Mathias, Chap. I. of Part II., is a discussion of electric discharges in the atmosphere. Besides St. Elmo's fire, lightning of various kinds, and lightning conductors, he includes also aurora. Prof. Mathias also supplements the work of Prof. Maurain by a discussion of the mobility of ions in the atmosphere, and the various laboratory ways of measuring it. Further, he discusses rainfall electricity, and writes three supplements at the end of the volume. The first and last of these, devoted respectively to the so-called black flash and to Vegard's recent work on the spectrum of aurora, are very brief. The second gives an account of the writer's own recent speculations on thunder and lightning.

As to the other contents, there is a copious bibliography at the end of each section, and at the end of the book an authors' index. As evidence of its completeness, it may be mentioned that under the heading "Elster et Geitel" there are 39 references, and the same 39 references appear on the same page under the heading "Geitel et Elster." There is no subject index, but there is a very full table of contents.

A few words must suffice for comment on the several contributions. M. Dongier's account of instruments for measuring potential gradient is well illustrated. Chauveau is quoted as to the great superiority of photographic recorders as compared with the Benndorf electrograph. In this we concur, but we should

associate the former type rather with the name of Kelvin than that of Mascart. Many important practical details are mentioned, including the reduction to the infinite plane. Diurnal variations are represented, perhaps somewhat superficially, by numerous diagrams.

The articles of Profs. Maurain and Mathias on ionisation and conduction show little overlapping, and form an excellent discussion of the subject.

Dr. Loisel commences with a general discussion of radio-active transformations and then passes to atmospheric phenomena, including the ionisation in closed vessels. In discussing Messrs. Campbell and Wood's observations he accepts their assumption that the diurnal variation of potential gradient has the same character at Cambridge as at Kew. This wants confirmation. Dr. Loisel gives a large number of data for the radio-activity of rocks and of mineral wells. The bibliography at the end of his article has 122 entries.

In his discussion of thunder and lightning, Prof. Mathias devotes considerable space to lightning conductors, and to a historical discussion of Franklin's discovery that lightning is an electrical phenomenon. The meteorological aspects, frequency and diurnal variation of thunder, are scarcely touched on. Aurora is not a prominent "meteor" in France, and the survey made of it is somewhat rapid. It refers, however, to Stormer's height measurements, and to the results of his mathematical calculations.

In his discussion of rainfall electricity, Prof. Mathias treats very fully of Dr. Simpson's observations at Simla, and inclines to the opinion of Nolan and Enright that "*la théorie préconisée par Simpson est pleinement compétente pour expliquer les phénomènes électriques observés des orages à foudre*" (p. 381). Another research to which he devotes special attention is the interesting recent work of Norinder on the electric field during thunderstorms.

M. Mesny, after discussing the apparatus and methods of radio-telegraphy, gives much valuable information about the variation in the facility of propagation of electric waves of various lengths, about variations of azimuth, and about atmospheric. In the latter topic he has many references to the work of Mr. Watson Watt.

M. Bosler narrates the historical development of our knowledge of earth currents, and describes the means of recording them employed at the observatories of Parc St. Maur and the Ebro. He discusses the diurnal variations observed at these two stations and Weinstein's results for Germany. Contrasting the records of earth currents and magnetic variations at Parc St. Maur, he infers apparently that the latter are largely

a consequence of the former, so far at least as irregular changes are concerned.

M. Girousse's discussion of artificial earth currents requires some knowledge of electrical engineering for its full comprehension, but the general conclusions are easily followed. What specially interests M. Girousse is apparently the financially important question of the electrolysis of underground pipes.

Taking the volume as a whole, British workers have no reason to complain of lack of recognition—except perhaps in the case of the thunderstorm work of Prof. C. T. R. Wilson—and their names are usually tackled successfully. Lennan, however, without the "Mac.," p. 286, has a somewhat Bolshevik appearance. In view of the present cost of printing, a similarly comprehensive work in English seems a remote contingency for years to come. Physicists of the older generation owed much to the works of Deschanel and Ganot, and present-day geophysicists who read French easily will find the treatise under notice of great assistance in their studies.

C. CHREE.

Modern Entomology.

- (1) *Anatomy and Physiology of the Honeybee*. By R. E. Snodgrass. (McGraw-Hill Agricultural and Biological Publications.) Pp. xv+327. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 17s. 6d. net.
- (2) *A General Text-book of Entomology: including the Anatomy, Physiology, Development and Classification of Insects*. By Dr. A. D. Imms. Pp. xii+698. (London: Methuen and Co., Ltd., 1925.) 36s. net.

IN 1910 the United States Bureau of Entomology issued a Bulletin by Mr. Snodgrass on "The Anatomy of the Honeybee," which immediately attracted attention, and has since maintained its place as the authoritative work on the subject. The present volume, as its title implies, has a wider scope, and contains a greater proportion of matter derived from the researches of others. The additions are judiciously selected and well presented. Nothing is final, but the book may stand as a fairly complete statement of our present knowledge of the morphology and physiology of this important insect, and the hope of the author that our ideas of the bee may hereby be placed "on a surer scientific basis than before" is amply justified.

An interesting section deals with the senses of the bee. There is no evidence that bees hear, but the senses of sight and smell are fully discussed, results published by investigators so recently as 1924 being duly incorporated. As regards smell, perhaps too much space is accorded to the rather crude experiments of

M'Indoo, which led him to deny to the antennæ any great importance as olfactory organs. Justice is done, however, to the more convincing work of von Frisch, who was careful to use non-irritant odours under some approach to natural conditions, and who not only reinstates the antennæ, but also considers that the pore-plates of the last eight segments are the special organs of smell.

The illustrations are for the most part admirable. Many are, of course, retained from the original Bulletin, and some of these have become very familiar from their recurrence in all manner of zoological text-books. But there are many new figures of an equally high standard of excellence. One of the least satisfactory bears the legend, "Isle of Wight disease mites," but there is no reference to these parasites in the text. Mr. Snodgrass is not of course concerned with pathology, but if he finds room for Dr. Rennie's *Acarapis*, it might be useful to indicate the particular tracheæ to which it is always confined.

In typography and clearness of arrangement the book is all that it should be, and Mr. Snodgrass has a lucid and pleasing style without a trace of transatlantic idiom, so that we need not complain if he conforms to his country's idiosyncrasy in the spelling of certain words.

(2) Dr. Imms has broken new ground in his "General Text-book of Entomology." The multitude of insect books published in English during the last fifty years have for the most part fallen into one of two categories. There is the Nature-study variety, chatty and discursive, and drawing largely from the incomparable J. H. Fabre, and there is the collector's hand-book variety, concerning itself entirely with the adult insect, and designed to aid the young collector in the identification of his pinned specimens. Few have dared to deal with the vast subject of entomology as a whole, and if this was a staggering task fifty years ago, what is it now, in view of the tremendous annual output of more or less original material? Thirty years ago Dr. David Sharp remarked that insects were the most numerous in species and individuals of all land animals, and estimated the number of known species at about 250,000. According to Dr. Imms, 450,000 species have now been described.

Just about a century has elapsed since W. Kirby and W. Spence completed—in four volumes—the first edition of a work which was destined to enjoy a great vogue for many years. The seventh edition appeared in 1856 as a single volume. This work, written in the epistolary style, was distinctly of the Nature-study order, and was deservedly popular for its store of information concerning the habits of all manner of insects.

In 1885 W. F. Kirby published an "Elementary Text-book of Entomology" dealing with the subject from an entirely different point of view, and doing what was possible, in the space of 240 pages, and with the aid of some excellent plates, to enable the budding entomologist to find his way among the orders and families of insects at that time recognised. The second edition appeared in 1892. Then, at the close of the century, came two remarkable works. The first portion of Dr. David Sharp's treatise on insects in the "Cambridge Natural History" appeared in 1895, and the concluding part in 1899. Meanwhile, in 1898, Dr. A. S. Packard published in America his "Text-book of Entomology."

Dr. Packard's work was entirely morphological, and appealed—and still appeals—to the advanced student of comparative anatomy. Dr. Sharp's treatise was, we believe, the first serious attempt to deal with the subject from all aspects, and, so far as was possible in the space at his disposal, he succeeded triumphantly. It is surprising how often workers in the most varied fields find in his volumes precisely the kind of information they require.

But Dr. Sharp cared not at all for applied entomology. The threatened extermination of a rare insect excited his indignation, but the too great abundance of a common species left him cold. His sympathy was distinctly on the side of the insects.

Now, during the present century, the number of workers in the economic field has vastly increased. It is even true to say that a large proportion of our recent advance in entomological knowledge is directly due to them. What did we know of mosquitoes or of fleas before their proved connexion with malaria and bubonic plague? Consider the condition of our acquaintance with Hymenopterous parasites before their importance in the control of crop pests was recognised. Dr. Imms dedicates his book to teachers, advanced students, and those engaged in research, and we feel sure that in the last category he had specially in mind that body of economic entomologists of which he is himself a distinguished member. If we add the fact that in a subject attracting so many workers, books a quarter of a century old are necessarily in many respects out-of-date, we see that a new venture was urgently called for, could any one be found sufficiently equipped and sufficiently daring to undertake it.

By what criteria must Dr. Imms' work be judged? Originality, except in the general scheme of presentation, would be a positive blemish. The essential points are that the selection of matter, necessarily very rigorous, should be well balanced and clearly presented; that the latest—not always the latest propounded, but the latest approved—conclusions should be incorporated, and that the student should be put

on the track of further information on the point which especially interests him.

On the whole, the book before us stands these tests extremely well. The bibliographies at the end of each section are most valuable, and the chances are that a "research worker," to use Dr. Imms' term, consulting the work on any particular point, will find a concise and trustworthy statement of what is known, and an indication of the sources whence more detailed information may be obtained.

We note that Dr. Imms does not cater for the medical entomologist, who, he doubtless considers, is well provided with his own special entomological text-books. We may instance the short chapter on fleas, which includes no figures of internal structure, and presents a scheme of classification not too recent and referring only to British species.

We congratulate Dr. Imms on the production of a book which will be valuable to a large number of students and indispensable to not a few.

C. W.

Industrial Research in Cotton.

Shurley Institute Memoirs. Vol. 3, 1924. Pp. vi + 362 + iv. (Manchester: British Cotton Industry Research Association, 1924.) n p.

THE volume under notice includes twenty-seven original papers in cotton research and an excellent summary of the literature on the action of light on dyes applied to cotton fabrics.

Our knowledge of the botany of the cotton plant is already very extensive, and it is of more than passing interest to find in these pages a further advance in the study of the cytology of a plant so long cultivated. A count of the chromosome numbers in many varieties of Old and New World cottons has shown that the numbers fall into two groups of 26 and 13 chromosomes, the former comprising the cottons of the New World and Egypt, and the latter those of Asia. Unsuccessful attempts to cross American or Egyptian with Indian cottons have often been made, and a possible explanation of the difficulty is thus established.

The effects on cotton of the mechanical action of several processes through which it passes in the spinning mill have been thoroughly investigated, and although tendencies in modern industrial practice are in the main justified, the precise information obtained is invaluable. The necessity for the control of the atmospheric conditions in testing and in many technical processes is strikingly demonstrated by investigations on the influence of humidity and temperature on the elastic properties of cotton hairs and the absorption of moisture

by raw and soda-boiled cottons. Recent botanical views on the micellar structure of cotton have been strengthened by further and more trustworthy information on moisture hysteresis in cotton, which extends to 1.8 per cent. and not to zero relative humidity as was formerly found. Using the Anderson capillary formula, the calculated diameter of the smallest pores (or the smallest distance between the micelles) is of the order of 1.3×10^{-8} cm.

Micro-analytical methods for the examination of small quantities of waxes are described and the main constituents of the waxes extracted from some American and Egyptian cottons are very similar. The phosphorus and nitrogen contents are consistently greater in Egyptian than American cottons, and in spite of environmental variations the phosphorus content can be used to distinguish between them. It is not possible to say how these results can be utilised in the improvement of the physical properties of cottons, but there are hopeful indications that their application may provide the grower with a means for controlling the quality of the crop. The cotton breeder is badly in need of information in a utilisable form on manufacturing quality, and those who dream of a cotton industry including the grower as well as the spinner may yet see their dreams realised.

A study of the swelling of cotton cellulose in potassium hydroxide solutions, following an investigation into the action of solutions of sodium hydroxide (the reagent used commercially in mercerising), has produced interesting results of a purely scientific nature. The increase in diameter of the cotton hair is less than half that attained in sodium hydroxide solutions, and maximum swelling obtains in the solution of maximum electrical conductivity. It is tentatively suggested that the action of the metallic ion on the swelling of cotton cellulose is consistent with the ionic theory of the swelling of colloids.

On glancing through these twenty-eight researches, one is struck by the number of positive results obtained. The keen practical man should welcome this precise information even though its immediate commercial application may be subject to modification by industrial limitations. Those only interested in the commercial usefulness of the knowledge, who have experienced difficulty in reading the earlier volumes in this series, will have no cause for complaint on this ground. Each paper in this volume is preceded by a short abstract in which the possible industrial applications of the results are written in terms which should be easily understood. Those who have not access to these memoirs, which are not purchasable, will find all these researches published in the Journal of the Textile Institute.

F. P. S.

French Science and Philosophy.

Histoire de la nation française. Par Gabriel Hanotaux.

Tome 15 : *Histoire des sciences en France.* Deuxième volume : *Histoire des sciences biologiques*, par Prof. Maurice Caullery ; *Histoire de la philosophie*, par René Lote. Pp. 619 + 12 planches. (Paris : Plon-Nourrit et Cie, 1924.) 50 francs.

Histoire de la nation française. Par Gabriel Hanotaux.

Tome 14 : *Histoire des sciences en France.* Premier volume : *Introduction générale*, par Émile Picard ; *Mathématiques, mécanique, astronomie, physique et chimie*, par Henri Andoyer, Prof. Pierre Humbert, Prof. Charles Fabry, Prof. Albert Colson. Pp. xx + 619 + 12 planches. (Paris : Plon-Nourrit et Cie, 1924.) 50 francs.

THE fifteenth volume of M. Hanotaux' "Histoire de la nation française" is devoted partly to a history of the biological sciences by M. Maurice Caullery, partly to the history of philosophy by M. René Lote. It is a great book in both senses of the term. Each author is extremely well qualified for his task and each has taken great pains in its performance. The proportion of space allotted to science speaks well for the understanding of the general editor, for there is another volume on physical and mathematical sciences, and M. Caullery is careful to lay down at once the right principle for dealing with science or philosophy in such a national work as this. "One cannot write a 'national history' of any science. The history of all the sciences is essentially international. . . . What can be done, and has been attempted here, is to take a particular country as a centre of observation and trace the connexions of the scientific movement there with the general march of thought."

France has a distinguished place in both parts of this volume. Cuvier, Lamarck, Claude Bernard, and Pasteur are a series which will bear comparison with the biologists of any other nationality, and in general philosophy the quality of French thought is well brought out by M. Lote when he speaks of the equilibrium of the French spirit—"raisonnable sans froideur, imaginaire sans fantasmagorie."

The work has been very well done, especially the letterpress, which would command a still larger sale if produced in two small volumes. The illustrations, which are abundant, will arouse more mixed feelings. They are mostly drawings—not executed with the highest French finish—of portraits, tombs, houses, connected with names in the text. The present reviewer finds the black and white drawings not unsatisfactory, but would be happier without the coloured plates.

The fourteenth volume, containing the history of mathematics, physics, and chemistry, came to hand

after the above was written, but it fully bears out the judgment we have expressed and is in some ways better than the fifteenth. M. Émile Picard writes a general introduction describing the characteristics of the French contribution to science and advocating some teaching of the history of science as part of the lycée course. On both subjects he is enlightening and impressive. The general quality of French scientific and philosophic thinking is admirably illustrated by the section on the history of mathematics by MM. Andoyer and Humbert. Vieta, Descartes, Fermat, Bernoulli's, Lagrange, Laplace, Cauchy; it is a magnificent series with which no other nation can compete. If science consists in "mathematising" knowledge, the French have done most in the modern world to advance it, and it is they and not the Germans who come nearest to the rôle of the Greeks. But these French volumes are conceived and executed in as great a spirit of impartiality as is consistent with the general idea of a national history; no great name is omitted, whether it be British, Italian, or even German, though the portraits and other illustrations are almost entirely French.

It is an eloquent testimony to the intellectual elevation of our neighbours that so large a share of a general history of the country should be given to science and philosophy and that the work should be done so well. There is certainly no parallel in any English history, and the two volumes together form perhaps the best extant sketch of the history of science, complemented by M. Lote's section which treats philosophy from the scientific view-point. This also is a feature more common among the French than with us. We heartily congratulate both them and M. Hanotaux on a valuable contribution to scientific synthesis. F. S. M.

Electrodynamics and Radiation.

Scientific Papers, mainly on Electrodynamics and Natural Radiation: including the Substance of an Adams Prize Essay in the University of Cambridge. By the late Prof. Samuel Bruce McLaren. Pp. vii+112. (Cambridge: At the University Press, 1925.) 8s. 6d. net.

THIS small volume of the papers written by the late Prof. McLaren before he met an untimely fate in the War, and now collected together by some of his friends, will undoubtedly be received with somewhat mixed feelings. The pleasure that we experience in reading and re-reading his delightful analyses of questions which have been the subject of such ardent discussions and are still far from settled, can scarcely be separated from the thoughts of the great loss which science suffered by his death.

The papers themselves are preceded by a short biography of Prof. McLaren, written by Prof. Hugh Walker, which gives an insight into the very human side of McLaren's personality. Then follow the papers on radiation and gravitation drawn up by Dr. J. W. Nicholson. Here we find the classical argument, developed, however, with exceptional analytical power and considerable elegance, against equi-partition and Newtonian mechanics, the conclusion being, as usual, that if we regard the normal oscillatory co-ordinates as being all statistically equivalent, then Newtonian mechanics involves equi-partition. It would, of course, be surprising if the result were otherwise, but the fault is not necessarily with the mechanics; the independent probability argument is capable of bearing at least some of it.

In the later parts of these papers McLaren branches off into highly speculative proposals. Taking the ether—with the electromagnetic equations to define its activity—and assuming that matter in its smallest element (electron) is merely a small spherical sink in the ether, much as a perfect conductor would in fact be, he develops a formal electromagnetic scheme which includes the usual hydrodynamical attractions between sinks as a possible gravitational force. Any such theory is, of course, open to the usual objection that it either assumes too much or results in too much, but it is here developed by McLaren with an attractiveness which compels attention.

In the second set of papers, edited by Prof. Hassé, these ideas are pushed further to include a theory of magnetism. Here the magneton is introduced as a ring sink in the ether—a perfect conducting circuit with a current in it—and calculations of the associated energy and momentum are made and compared with fundamental data. The revolving electron theory of the magneton is rejected as being incapable of explaining paramagnetism on the lines developed by Langevin, the idea being that since the mechanical force exerted on an electron by a magnetic field is at right angles to the direction of motion of the electron, it can never do the work which is required for the orientation of the orbit. There appears to be a slight confusion of thought in this criticism. When a circuit carrying a current moves in a magnetic field, the magnetic forces acting on the contained electrons have a double effect. The components at each point perpendicular to the main direction of the current flow balance the mechanical reaction forces acting on the element there, and the other components balance the electrical or other forces driving or retarding the current. The energies associated with these two actions are, in the usual circumstances, equal in amount but opposite in sign, so that the total is zero, and the only

effective result of the action of the magnetic field is a redistribution of the energy as between the mechanical and internal types.

In the last paper, not previously published, and now edited by Prof. Havelock, McLaren discusses the propagation of a disturbance in a dispersive medium by the Fourier method. Here he proves that the mathematical difficulties, which at first appear to be inherently involved in the method, do not in fact present themselves, and that results are obtained which are fully consistent, so far as it is possible to follow them, with the physical ideas of propagation by waves and wave groups.

This short review will perhaps give some idea of the scope of McLaren's work, which was all accomplished in the short space of three or four years. The book into which it is now all collected will serve as a worthy memorial—it is produced by the Cambridge Press in their usual excellent style—to a fallen colleague, and it can be recommended to every one interested in the subjects with which it deals. They will find in it an interesting and still to great extent novel discussion of matters in which alternative points of view are still more than welcome.

G. H. L.

Our Bookshelf.

Pygmies and Bushmen of the Kalahari: an Account of the Hunting Tribes inhabiting the great arid Plateau of the Kalahari Desert, their precarious Manner of Living, their Habits, Customs and Beliefs, with some reference to Bushmen Art, both early and of recent date, and to the neighbouring African Tribes. By S. S. Dornan. Pp. 318 + 16 plates. (London: Seeley, Service and Co., Ltd., 1925.) 21s. net.

THE lower the savages, the more difficult it is to make observations among them—to endure the adverse climate or conditions of their habitat, to follow their shifting, unsettled mode of life, to overcome their diffidence. Our literature about the pygmy race and the so-called primitive food-gatherers is as scarce as it is important for anthropology. The recent additions by trained scientific field-workers—the books of Prof. and Mrs. Seligman on the Veddahs, of Dr. Radcliffe-Brown on the Andamanese, of the Rev. W. Koppers on the Firelanders—have aroused great interest and already influenced anthropological argument. About the Bushmen we know, in spite of some good older accounts, only too little, and the present volume is welcome, written as it is carefully, in a clear attractive style, and by one who can claim that “for the opinions expressed in the book the author alone is responsible.” It represents mainly the writer's own experiences with the Bushmen and Bechuanas.

The bulk of the volume and its most valuable part consists of Chaps. v.-xxii., on the Bushmen of the Kalahari. The descriptive pages are good, especially when they refer to tangible objects—clothing, household goods, implements, weapons and such like; or the typical pursuits—the chase, warfare, trekking and

fishing, which, surprising as it sounds, exists in the arid desert of the Kalahari. The sociology of these nomadic savages is given but in a cursory manner, as is natural from an amateur ethnographer. Even in a chapter with the promising title, “Organisation of Family and Clan,” there are, for six descriptive pages on physical appearance, only one page and a half on sociology—and this very slightly treated. Some interesting information about the tests in hunting skill and endurance necessary for marriage are given in Chap. xiii. (“Family life—Marriage, Children, etc.”), but the remarks about sexual relations, family life and kinship ties do not go beyond generalities and will be of little use for the comparative sociologist.

The most interesting passages of the book are detailed statements of personal experiences of the writer, as they throw some light on the mentality of the natives and on their conduct in ordinary life. What Mr. Dornan has to say about “Food and Feeding” (Chap. xii.), about personal relations, about their beliefs and folklore (Chaps. xv.-xix.) is often quite good. The chapter on “Knowledge of the Veld and its Lore” shows us the native as a good observer, capable of empirical conclusions and logical argument. It should be helpful in dispelling the myth of “savage prelogical mentality.”

B. M.

In Southern Seas: Wanderings of a Naturalist. By Dr. W. Ramsay Smith. Pp. xviii + 297 + 16 plates. (London: John Murray, 1924.) 16s. net.

IN this attractive little book a naturalist at ease and in his holiday mood gives us his impressions and personal opinions on several subjects, which he has treated at other times professionally and of which he takes now a bird's-eye view during a recreation trip through New Caledonia, the New Hebrides and Northern Australia. The flippancy of style, which seems to be considered a matter of duty in such books, does not interfere substantially with the serious purpose of the book, directed mainly to the study of native races. The traveller in the South Seas is naturally led to melancholy musings about the appalling extent of depopulation, the decay of native culture and custom—and he is made to reflect upon the cause of it all. “The total effect of all well-intentioned or ill-meaning interference with long-established customs and observances, which were evolved with the race itself and were necessary for its existence and well-being, has too often been to break up the social fabric and destroy physical vigour; it has meant degeneracy or death or both.” Dr. Ramsay Smith asks the question which must have occurred time and again to every anthropological field-worker and to any thinking and sympathetic white man in contact with natives: “Why should it be considered essential to interfere with such customs?” Above all, it might be added, why should we try to destroy all which the natives hold sacred and important, their beliefs, rites, morals, and that while our own religion, which we try to force on them, becomes but its own travesty once it has been grafted upon stone-age mentality. “There is no guarantee that the oil or even the Lord's anointed will not turn rancid in some of these places,” says the author, and indeed some reflection might have warned us that they are bound to; experience teaches always the same lesson—that they turn

rancid and poisonous, and that in spite of the best intentions.

The five chapters on Australian aborigines are instructive, especially where the writer deals with problems of race and physical anthropology. It is a pity that no references to other authorities are given, while the information is obviously not all based on personal field-work. About the Melanesians there are certain extraordinary statements, such as that "the savage lord of creation does little or no work except to make his wife or wives work" (p. 52). Those of us who know the Melanesian at first hand will feel astonished how any one who has visited the islands even on a flying trip could have carried away such an impression.

B. M.

Nauka Polska: jej Potrzeby, Organizacja i Rozwój. Tom 5. Pp. vi+553 (Warszawa: Im. Mianowski-ego, 1925.)

La science polonaise: ses besoins, son organisation et ses progrès. Résumé français des articles parus dans le volume 5. Pp. 36 (Varsovie: J. Mianowski, 1925.)

FROM the French résumé of the articles in the larger work in Polish we can learn in outline the needs, organisation, and progress of science in Poland. This is the fifth annual volume which has been issued by the Caisse J. Mianowski, an institute for the encouragement of scientific work. Earlier volumes have dealt with the more urgent scientific needs of Poland, proposals for the allocation of funds, and a report of a congress on scientific organisation. Some of the more pressing problems concern agriculture, health, education, sociology, and geological survey. There are six universities—Warsaw, Cracow, Leopold, Lublin, Wilno, and Poznan, and local scientific societies at Plock, Thorn, Przemysl, and Sandomierz. Conferences have been held on physiography, on museums, on education. There are some foundations, the Academies at Wilno and Zamosc and the astronomical observatories at Vilno, Poznan, Cracow, and Warsaw, and a monument to Copernicus at Warsaw. Information has been collected as to the organisation of science in other countries—in France, Italy, Denmark, Czechoslovakia, and Finland. M. J. Wojciechowski contributes an article on "The co-operation of the state and of industry in scientific researches in England," with references to the articles by J. W. Williamson and Dr. Kenneth Lee in *NATURE* for November 15 and December 6, 1924. There is an evident willingness to co-operate with work abroad. Relations have been cultivated with France, Italy, Belgium, England, the United States, Switzerland, and Czechoslovakia; Poland has been represented at some forty international conferences. Polish savants—about two hundred—have been encouraged to travel. Scholarships are offered to foreign students. Contact has been made with the League of Nations Committee on Intellectual Co-operation.

It appears that, although with restricted finance, an endeavour is being made to prepare the conditions for a scientific advance. For this reason it may be increasingly important to watch the future volumes of this annual. The French abstract is already a useful interpreter. Perhaps in the future English and German abstracts could also be offered.

H. R.

The Mineralogy of Scotland. By the late Dr. M. Forster Heddle. Edited by J. G. Goodchild. Reprinted under authority of Alex. Thoms by the Council of University College, Dundee, assisted by D. E. I. Innes. Vol. 1. Pp. lviii+148+51 plates+4 maps. Vol. 2. Pp. viii+250+plates 52-103+7 maps. (Dundee: Frank Russell, 1923-1924.) 15s.

BY the publication of these two handsome volumes at so moderate a price, Mr Alexander Thoms and the Council of University College, Dundee, deserve the thanks of all interested in the mineralogy of Scotland. Heddle's well-known work has, since its appearance in 1901, been an indispensable book of reference for mineralogists and petrographers, and it is satisfactory that so valuable a compilation has not been allowed to suffer the common fate of a mineral index and go permanently out of print.

It is unfortunate, however, that the opportunity has not been taken of removing some of the defects for which the original edition was criticised. The book possesses no adequate index, the first requisite in a work of this character, and in consequence the labour of tracing the descriptions of the minerals and their occurrences throughout the text is as long and irritating as it should have been unnecessary. The complete disregard of recent published work is also to be regretted. Thus, the interesting contributions made to the mineralogy of Scotland by the officers of H.M. Geological Survey working in Mull are not mentioned, and, as a result, the accounts of the mineral occurrences in that island are incomplete and sometimes erroneous.

Despite these blemishes, the book remains a lasting memorial of the enthusiasm and ability of the late Prof. Heddle. It is well printed and produced, and the illustrations are of excellent quality; but it is necessary to warn the reader that not a few of the drawings are examples of artistic crystallographic draughtsmanship rather than actual representations of the crystallography of Scottish minerals.

Substation Operation. By Prof. Edwin Kurtz. Pp. xiii+261. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 12s. 6d. net.

THIS book is intended to help the workman to understand the principles of substation operation. It is a good attempt at giving somewhat advanced technical knowledge in such a way that it can be readily assimilated. Very little theory is given, and much of the information has been compiled from official American sources. We were interested to read of the care that is taken to protect the operator from shock and burns. Not only has he to wear rubber gloves, but he has to wear leather gauntlets over them. He has also to blow in the gloves to see whether there are any holes in them. In addition he has to put on a leather coat, which must be kept scrupulously clean, and when working with high tension switches he must stand on a stool thoroughly insulated from earth and so constructed that it cannot possibly tip over.

Full instructions are given to revive a man when he has had a shock. The patient is then to be given some stimulant, "such as one teaspoonful of aromatic spirits of ammonia in a small glass of water, or a drink of

hot ginger, tea or coffee." We are told not to use water to put out a fire at a substation before the station has been made completely "dead." The reason given for this is that the operator would receive a shock if he directed a jet of water on to a "live part." This may be true for very high voltages, but it is not true at low voltages. This book will interest station engineers in Great Britain.

Physiologische Pflanzenanatomie. Von Prof. Dr. G. Haberlandt. Sechste, neubearbeitete Auflage. Pp. xvii+671. (Leipzig: Wilhelm Engelmann, 1924.) 22 gold marks.

THIS work, originally published in 1884, is best known to English students from Prof. Drummond's translation of the fourth German edition. A fifth edition appeared, during the War, in 1917. The latest edition has been brought more up-to-date, especially by additions to the "notes" at the end of each chapter, the most useful feature being the references to recent German research. Some of the rather dogmatic statements of earlier editions have been modified, and it is acknowledged that modern cytological work has reopened questions, such as those relating to the origin of the chloroplastids and other chromatophores, which have previously been regarded as answered. By deletion of some less important passages the size of the book has been very little increased, though room has been found for brief accounts of such new discoveries as those of Merl and Czaja on the mechanism of the Utricularia bladders. Possibly owing to the lack of access to recent literature, English and American work appears to have been almost entirely ignored. Thus the account of mycorrhiza is very incomplete. Prof. Haberlandt realises that the subject will soon require a more basic revision than can be given without re-writing the whole book, but declares it is not possible for him to undertake this.

Fuel: Solid, Liquid and Gaseous. By Prof. J. S. S. Brame. Third edition. Pp. xv+388. (London: E. Arnold and Co., 1924.) 18s. net.

PROF. BRAME points out that the second edition of his book was published in 1917, when no large amount of revision was possible; since the issue of the first edition there has been very considerable extension of our knowledge of fuels for internal combustion engines, of the use of powdered coal as fuel, of the ignition points of fuels of all classes, on the velocity of combustion of gaseous mixtures, and on problems of low temperature carbonisation. All these subjects have been revised, and the chapters on liquid fuels for internal combustion engines have been re-written. Additional material on the composition and the coking properties of coal has also been included. The author has made full use of the publications of the Fuel Research Board, and has evidently found them of great value.

Metallurgy: an Elementary Text-Book. By E. L. Rhead. New and revised edition. Pp. xii+403. (London: Longmans, Green and Co., 1924.) 7s. 6d.

MR. RHEAD's little book on metallurgy was first published thirty years ago, and has been through many editions. The copy before us is a new and revised

edition published late last year. Considerable additions have been made throughout the book, especially in the metallurgy of iron and steel, copper, silver, gold, and nickel. Certain processes which have become obsolete or the importance of which has diminished have either been deleted or condensed into smaller compass. The author, however, has wisely retained certain other processes which, although obsolete or much modified, make clear the principles underlying their modern successors. Elementary metallography has been introduced, and we think he has done wisely in taking this step. There is no better method of emphasising that all metals and alloys at whatever stage of their manufacture, provided they are solid, have a definite structure. H. C. H. C.

The Marketing of Metals and Minerals. A Series of Articles by Specialists. Edited by Josiah Edward Spurr and Felix Edgar Wormser. Pp. xii+674. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 30s. net.

THIS work consists of a series of articles, each written by a specialist, describing the methods of commercial dealing in the metals, ores and non-metallic minerals produced by the labours of the metallurgist and the miner. The economic side of the great mineral industries has been generally neglected in literature, and the present work will be welcomed by a large circle of readers. Unfortunately for us, it refers almost exclusively to American conditions, and whilst therefore of very great value to any one connected with the mineral industry in the United States, its usefulness in Great Britain will be limited to the relatively few people who deal with the United States in mineral products. A companion volume dealing with British conditions and methods would be of very great value, especially at the present moment.

Laboratory Manual of Organic Chemistry. By Dr. Harry L. Fisher. Second edition. Pp. xii+338. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 11s. 6d. net.

DR. FISHER has introduced some improvements and additional experiments into the second edition of his excellent book. The principal feature is the thoroughly practical character of the information, and the innumerable hints and details given in the descriptions of preparations and experiments will be found of the greatest value to students and demonstrators. References to important new work are frequently given. The section on elementary analysis is very detailed, and is perhaps the best account in existence.

A Class-Book of Chemistry. By G. C. Donington. Part 5: *Organic Chemistry.* By Prof. T. M. Lowry and Dr. P. C. Austin. Pp. vi+531-706. (London: Macmillan and Co., Ltd., 1925.) 3s.

THIS volume is a continuation of Donington's well-known class-book, and a further volume on physical chemistry is promised. The treatment is clear and accurate, and several good experiments are included. The book is suitable for medical and pharmaceutical students, and provides generally a useful introduction to organic chemistry. Recent work (e.g. on the structure of sugars and starch) is included.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Fluorescence of Cadmium Vapour.

IN the course of the study of band spectra of cadmium and zinc, the question arose whether the vapours of these metals show a fluorescence analogous to the well-known green fluorescence of mercury vapour. To decide this problem, the following experiment was made.

A quartz bulb was thoroughly evacuated, adsorbed gases being removed by heating it to a high temperature for some days. Then a few milligrams of pure cadmium were distilled into the bulb, which was finally sealed off from the pumps. The bulb being put into a nichrome-wire furnace, a beam of exciting light from a condensed spark, an arc, or a mercury lamp was projected through the bulb by the aid of a quartz lens.

It was found that the fluorescence of cadmium vapour, in the form of a blue-coloured beam of light, strictly limited to the path of the exciting beam, makes its appearance and continues over a considerable range of temperature and density of vapour. By increasing gradually the temperature of the furnace, first traces of the fluorescence appear about 450° C.; with further increase of temperature the intensity of the fluorescence is augmented, and from 600° to about 750° it is very pronounced. At a still higher temperature the direct observation of the fluorescence is impeded by the bright glow of the furnace. Using a blue glass screen to cut out the red glow of the furnace, however, the fluorescence can be observed up to a temperature of about 950° and more, its intensity being considerably diminished.

In order to determine the exciting wave-lengths, various sources of light were employed: a condensed spark with the electrodes of cadmium, zinc, aluminium, magnesium, copper, lead, tin, carbon and iron, iron, cadmium and carbon arcs, and also a mercury lamp. Almost all these sources gave a more or less intense fluorescence. Especially strong fluorescence is produced by the cadmium spark; a very faint one by the magnesium spark; the carbon arc does not produce any fluorescence at all.

The excitation of the fluorescence being produced by such different sources of radiation proves the spectral extent of its excitation to be rather broad. It lies at any rate below 3000 Å.U., as not only a thin sheet of glass, but of uviole as well, put in the path of the exciting beam extinguishes the fluorescence completely.

An addition of small quantities of other gases seems also to have a destroying influence upon the fluorescence, as proved by the following experiment: The bulb, showing a very intense fluorescence, was heated by the Bunsen flame for fourteen hours. It was found then that its fluorescent property disappeared totally. This is probably due to the diffusion of hydrogen from the flame through the red-hot quartz into the bulb. To demonstrate the presence of hydrogen in the bulb, the latter was excited at room temperature by the electrodeless discharge of a Tesla transformer. In the spectrum were found some hydrogen lines, which were absent before the heating.

In order to examine separately the influence of temperature and density upon the fluorescence, a quartz cylinder provided with a side-tube and having

two plane-parallel windows was used. The cylinder and the tube could be heated independently in two separate furnaces. First of all it was noted that during the rapid evaporation of metal drops condensed on one of the windows, the fluorescence appears particularly intense. However, the existence of fluorescence in the bulb, where a permanent distillation does not take place, proves that the evaporation is not an indispensable factor in the appearance of fluorescence.

The study of the spectrum of the fluorescence is rather difficult owing to the long exposures (several hours even when a spectrograph of small dispersion was used) which are necessary on account of a comparatively small intensity of light. It is also difficult to remove the exciting light scattered by the walls of the bulb.

The photographs of the spectrum and the curves got from these by a self-registering microphotometer show, however, that the spectrum has the appearance of a broad continuous band extending approximately from 5000 to 3950 Å.U. The decrease of intensity, especially towards the more refrangible end of the spectrum, is very gradual. The maximum of intensity falls about 4630 Å.U. This type of spectrum is analogous to the fluorescence spectrum of mercury vapour.

Further detailed investigations of the phenomena described are in development.

W. KAPUSCINSKI.

Warsaw,

Physical Institute of University,

June 1925.

The Band Spectra associated with Carbon.

THERE are now so many as thirteen band groups associated with carbon and its compounds. Some of these, such as the violet CN group, have been studied exhaustively, both empirically and upon the basis of the quantum theory. I have endeavoured to arrange in progressions and to assign vibrational quantum numbers to all of these groups, where such work has not yet been done, and several interesting new relations have resulted.

Lemon (Proc. Nat. Acad. Sci., 11, 41, 1925) has found that the first negative group and the comet-tail bands (low pressure CO bands) appear and disappear under the same experimental conditions, and Blackburn (*ibid.*, 11, 28, 1925) has made a quantum analysis of the former group. Simultaneously, Baldet (*Comptes rendus*, 180, 271, 1925) published measurements of the four heads of each of the 30 bands of the comet-tail group. Using the data for all four heads, I find that the first head is given by the equation

$$\nu = 20485.4 + (1550.46n' - 14.07n'^2 + 0.043n'^3) - (2198.6n'' - 15.00n''^2).$$

The remaining three heads are then given by substituting for the constant term 20471.6, 20359.1, and 20346.1 respectively. Using the older data quoted by Jevons (*Phil. Mag.*, 47, 586, 1924) as well as Blackburn's data, I obtain similarly for the heads of the first negative group

$$\nu = 45655.4 + (1704.42n' - 29.3n'^2 + 0.7n'^3) - (2197.03n'' - 15.17n''^2).$$

The assignment of the final vibrational numbers (n'') is very certain in the case of each of these groups, and it is evident that well within limits of error both groups correspond to the same final state, and are therefore due to the same molecule. The experimental evidence indicates that the comet-tail bands are due to CO, while, as the name indicates, the first

negative group is probably due to an ionised molecule. Hence it is probable that both groups are due to ionised CO.

The assignment of values of n' for the comet-tail bands is slightly uncertain, that adopted neglecting the $\lambda 5281$ band given only by Baldet. This band is very weak and $3\text{\AA}$ out of position. If included, it must be the 0,0 band of the group, an unlikely but not impossible state of affairs. The intensity distribution is such as to favour the initial states ($n'=0$ to 11, while $n''=0$ to 3 only), quite an unusual distribution. However, the distribution of intensity among the values of n' , as observed by Fowler (M.N. Roy. Astron. Soc., 70, 484, 1910) and by Baldet (*loc. cit.*), is definitely a high temperature distribution, while the quite different distribution observed in a helium mixture, by Merton and Johnson (Proc. Roy. Soc., A, 103, 383, 1923), is equally definitely a low temperature distribution.

The high pressure CO bands found by Fowler (*loc. cit.*) form a single n'' progression ($n''=0$ to 5, while $n'=0$, presumably). Within the very large limits of error, this set of final states is the same as the set of initial states of the comet-tail bands. Much more accurate data for the high pressure bands are needed in order to settle the question definitely, but the experimental conditions needed for the production of these bands favour the identity, I believe.

The third positive group is well worth a detailed remeasurement and quantum analysis, the successive minima observed by Wolter (*Zett. wiss. Phot.*, 9, 36, 1911) doubtless corresponding to the origins of successive bands of a sequence. Accurate data (by Wolter) are available now only for the six heads of the first band of each sequence. The resulting $f(n')$ is closely similar to that of the common nitrogen progression, but is definitely not the same.

The triplet bands measured by Merton and Johnson (*loc. cit.*) have the same unusual intensity distribution noted for the comet-tail bands ($n'=0$ to 6, $n''=0$ and 1 only). The single resulting n'' interval ($\Delta\nu=1714$) is practically identical with the corresponding interval for the third positive group, but no conclusion can be drawn without known values of other intervals. The $f(n')$ for this group is not related to any other.

The fourth positive group is very extensive and is noteworthy in corresponding to a very *slow* initial vibration ($\Delta\nu=500$, approx.) and a very *rapid* final vibration ($\Delta\nu=3000$, approx.). No other new relations between the progressions of the various carbon groups have been found, so that at present no further inferences as to the identity of the emitters can be drawn from this line of evidence.

RAYMOND T. BIRGE.

Department of Physics,
University of California,
June 8.

Sensitive Jets and Flames.

MANY types of sensitive flame have been described from time to time, and measurements of the range of pitch and of the pressure at which they are sensitive have been made, but I have not seen any quantitative record of the variation of the length of such a flame or jet. In this connexion some experiments made recently by Mr. E. Tyler and myself with jets of coloured water flowing into still water seem to be relevant. At a certain distance from the nozzle from which it is issuing the stream suddenly breaks down into general turbulence. Measurements of the continuous length of the jet, L , under different heads of pressure were made, and hence a curve of velocity of

efflux, V_0 , against L obtained. Two of these are shown in Fig. 1; they have the form of rectangular hyperbolæ; a similar curve was obtained with a jet of air mixed with smoke.

The shape of these curves can be accounted for on similarity principles. The point at which the jet breaks up is taken to be that at which the Reynolds' criterion VD/ν (D =diameter of jet and V =mean velocity at this point, ν =kinematic viscosity) has reached that value at which the motion becomes turbulent. If the initial velocity at the nozzle be increased, the critical velocity, V , will be reached at a point nearer the nozzle; L will therefore become smaller as V_0 is increased. The effect of altering D_0 or ν may likewise be predicted. Introducing L into the "criterion" in the form of a function of D_0/L ,

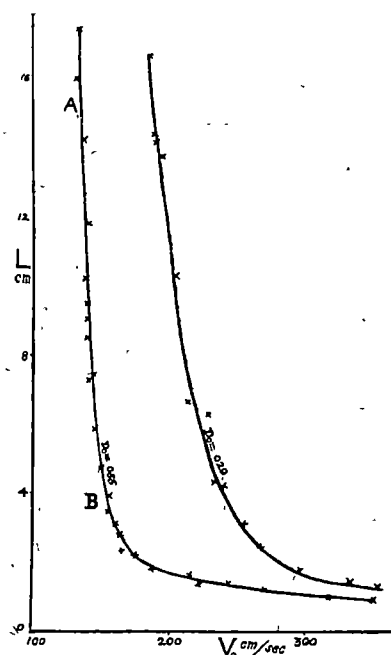


FIG. 1.

D_0 being the diameter of the nozzle, one obtains $V_0 = K \frac{\nu}{D_0} \cdot f\left(\frac{D_0}{L}\right)$. Expanding $f\left(\frac{D_0}{L}\right)$ as a linear function, and retaining two terms only of the expansion, since D_0 is small compared with L in sensitive jets, we get $V_0 = K_1 \frac{\nu}{D_0} + K_2 \frac{\nu}{L}$, that is, LV_0 is a constant for a given nozzle and gas.

Further, Kohlrausch and also Krüger have shown (*Ann. der Phys.*, 1881 and 1920) that, in a jet issuing from a circular nozzle, vortices are produced periodically with frequency n , given by $V/nd = \text{constant}$, d being a linear dimension dependent on the bore of the nozzle. The jet should respond most readily to tones of this frequency, or sub-multiples thereof, and a high-velocity jet to sounds of high frequency. When a jet of gas is ignited, the combustion complicates matters, as the visible part of the jet lengthens at first as the velocity increases; but Rayleigh showed that, over the range for which they are sensitive, such flames behave in most particulars like unignited jets, the progress of which is made visible by smoke. Experiment showed that a sudden small increase in the velocity of the gas feeding a sensitive flame brought the turbulent point—visible as a "flare"—nearer to the nozzle.

The other common experience with sensitive jets

and flames, that they are sensitive only over a small range of gas pressure, and, therefore, of efflux velocity, is shown by the curves and by theory. It is a consequence of the hyperbolic relation between L and V_0 , that at a certain value of the latter a small increase in velocity due to aerial disturbances causes a large change in length; so that in using a sensitive flame it is necessary to work on the part AB of the curve.

E. G. RICHARDSON.

University College,
London, W.C.1.

Science and Intellectual Freedom.

ON my return from abroad a few days ago, I found your letter of June 30 awaiting me. Allow me to express regret that circumstances prevented an earlier reply. Perhaps it is not too late for a brief statement of opinion on the controversy raised by the trial of Mr. J. T. Scopes of Tennessee.

Two questions of supreme importance have emerged: Liberty of scientific research, and the bearing of the doctrine of evolution on religion.

It is certainly an astonishing thing that, after the history of human thought during the last two hundred years, the legislatures of States which lay claim to some degree of civilisation should be found restricting science within limits prescribed by special interpretations of Holy Scripture. It does not seem to have occurred to these good people that, on such conditions, scientific research becomes impossible. Nor do they see that they are seeking to restore that very state of things which delayed the advance of human knowledge for centuries. They have still to learn that truth must be sought for its own sake.

Again, they are mistaken in thinking that the doctrine of evolution is anti-Christian. To my judgment, exactly the opposite is the fact. Evolution teaches the unity of all creation: it reveals an organic relationship among all living things, making us all akin: it enables us to form a conception of the Creator as One who is not remote from us in some transcendent sphere, but is Life of our life and continually at work in the universe. These are Christian ideas: they may be said to be among the essential ideas of Christianity.

As to the early chapters of Genesis, their sublime accounts of the beginnings of things lose all their true value if we regard them as scientific statements. They are full of meaning if we view them as the expression of fundamental religious principles in the language and imagery of the age to which they belong.

CHARLES F. ARMAGH.

THE Tennessee trial has given the readers of NATURE an amusing motley of opinion, but are we not, perhaps, treating the rejection by "Main Street" of the much over-advertised Mr. Scopes too seriously and missing the real significance of the occasion? Is not a lesson of profound social importance behind it all? We are talking glibly of interference with "freedom of thought." Is there any such thing—even in the ranks of our boasted "science"? Are not the teachers, for the most part, just repeating what they have been told, without exercising any thought? Is the Pauline injunction, *Prove all things, hold fast that which is good*, in any way followed? If it were, societies would have no difficulty in meeting costs of publication. Whatever may be the case in biology, it certainly is not on the physical side. We mostly use the "Main Street" method but are at the disadvantage that we have no bible holding our faiths which can be put into the hands of the public. Consider our Press, consider our politicians—the Cabinet,

even our Public Schools, are not all these located in "Main Street"?

Scientific method, the method of proving all things, is only known to and used by the few who are real makers of knowledge—science factors. The scientific, like all artistic gifts, we must recognise to be an "inborn error of metabolism." Our text-books are as dogmatic as is the great book used of "Main Street." This not only has the advantage of great beauty of language but also a concealed authority behind it—Man's innate belief in a superior being—which we cannot command. The "Aunt Susans" who teach it do so with a thoroughness and sense of conviction which we can in no way match.

Any one who wishes to gain some inkling of its power should study Ruskin's "Modern Painters"—the work of an arch critic gifted with a mind of transcendent power, not an obscurantist. The practical achievements of the scientific mind are blinding us to our failure to teach and use scientific method in our ordinary affairs. We need be in no hurry to force our speculations into the schools—better not. We do need to teach all to respect our method, though, maybe, it is that used only in the best circles. We need, on all possible occasions, to make clear, to ourselves and others, the significance of the assertion, to which Sir Bryan Donkin and Sir E. Ray Lankester directed timely notice recently, made by the late W. K. Clifford—*It is wrong always, everywhere and for any one to believe anything on insufficient evidence*—let alone teach it as truth, as is so often done in our classes. We have gradually to repave "Main Street" with such doctrine: our difficulty is that most of us are born to live in it—as it is. Yet when Bishops can write as do those of Birmingham and Durham, we need not altogether despair—though these also are probably "metabolic errors."

HENRY E. ARMSTRONG.

Changes in the Ultra-violet Absorption of Gelatin.

IN some investigations on the ultra-violet absorption of gelatins, we have discovered that the absorption spectrum changes in a characteristic manner according as the gelatin is on either side of the iso-electric point, indicating that the different P_H values are associated with a definite change in the chemical constitution. Taking the iso-electric point as 4.7, when the P_H value of a gelatin rises above this, there is a characteristic increase in absorption from about 3500 Å.U. towards the red end, while with a fall in P_H there is an increase in absorption in the region of shorter wave-lengths. These very marked changes in ultra-violet absorption would appear to provide a valuable means of investigating minute changes in the constitution of gelatins.

T. THORNE BAKER.

L. F. DAVIDSON.

The Oogenesis of Lumbricus.

REFERRING to Dr. Graham Cannon's letter in NATURE of July 18, I may be permitted to remark that the reason why it is not only inadvisable but even unprofitable to discuss oogenesis in general, on the basis of work done on a single species of one order, is that, unlike the chromosomes, the Golgi bodies and mitochondria are variable in behaviour in different orders, and even within a single family. This is the most important fact which recent researches on the cytoplasmic inclusions have revealed, and, of course, throws a clear light on the question of the status of these bodies in heredity.

J. BRONTE GATENBY.

Trinity College,
Dublin.

Regions of Tension and Continental Drift.¹

By Dr. J. W. EVANS, F.R.S.

IN many areas the earth's crust has been subjected to compression manifesting itself in folding, cleavage, thrust-faults, and certain types of igneous activity. Such compression may prevail over an extensive region, or may be of a purely local character. In the former case, it is usually attributed to the progressive contraction of the earth's interior, although this has been disputed by some authorities. In the latter, it is merely an incident in the development of more extended structures. The results of compression have long been studied, but comparatively little attention has been given to the occurrence of tension in areas where it has left evidence of its existence in the form of joints, normal or slip-faults, occasionally replaced by monoclinical folds, dykes, and other characteristic igneous phenomena.

The distribution and direction of the jointing, the slip-faulting, and the dykes of western Europe of post-Hercynian date, are all due to tension, producing stretching, fracture, and separation, and together they imply relative movement, or drift, in the rocks with which they are associated.

The most prevalent strike of these fractures in the British Isles and western France is from north-north-west to south-south-east, implying a drift from east-north-east to west-south-west, or *vice versa*. However, in the Devon-Cornwall peninsula there appears to be a general downward slip to the south-west, modified later, it would seem, by a movement towards the north-west. In Skye the faults posterior to the igneous activity seem to show a similar change in the direction of the tension. In the north-west of Connaught, of Ulster, and of Sutherland the faults appear to strike as a rule north-east and south-west, implying the presence of a drift to the north-west, but in western Ulster, and in Mayo, this appears to have been preceded by an earlier tension directed towards the south-west or south-south-west, indicated by the north-west and south-east or west-north-west and east-south-east basic dykes.

Closely connected with the drift of the surface-blocks must be the stretching of the presumably plastic zone beneath. Indeed, it would seem that it is this stretching or slow flow which is the immediate cause of the minor fissuring of the crustal rocks. The blocks which are thus formed are then so disposed relatively to one another as to cover, so far as possible, the extended space. This may happen in two ways:

In the south-western peninsula of England and other localities the fault-fractures had originally considerable hade, usually directed to the region of weakness, and the extension took place by the downward slip of the block on the upper side of each fault.

In Skye and elsewhere the hade of the fissures seems originally to have been practically vertical; but the blocks between the faults were afterwards inclined, so that the beds which were formerly nearly horizontal now dip in a direction opposite to the faults. In this case the covering of the extended area is effected by

the tilting of the blocks. It is probable that in such cases the underlying magma has, it is suggested, flowed in the direction of the hade of the faults.

The volcanic activity in the west of Scotland and in the north-east of Ireland commenced, on the evidence of plant-remains, early in the Eocene, and may have continued for a great portion of that period. The faulting which has been described must have been of still later date. It is indeed impossible to fix any limit to the continuance of the tension. How far it was present in Mesozoic times we cannot say with certainty, but it apparently had a beginning in the Permian.

The drift towards the west (south-west or north-west) in western Europe seems to have been widespread, though greater in some regions than in others, but everywhere east-and-west distances appear to have been increased.

We are not in a position to estimate the total amount of this extension. It could only be calculated if we knew the width of each joint, the hade of each fault-plane, the direction and amount of the movement in it, and the thickness of each dyke. It does not, however, seem likely that the total relative change of distance between Central Europe and western Ireland has exceeded, say, 6 to 12 miles (10 or 20 km.) since Triassic times.

The true significance of this drift becomes evident on examination of a depth-chart of the North Atlantic. It is at once seen that the approximately north-west and south-east strike of different forms of fracture that is so prevalent in the British Isles and western France is related to the ocean-deep of which the north-eastern boundary runs roughly south-east and north-west, parallel to the French coast of the Bay of Biscay, out into the open Atlantic; and that the north-east and south-west strike which is found in the north-west is apparently similarly related to the edge of the trough that extends from south-west to north-east beyond the Hebrides. The drifts to the south-west and north-west seem to be towards these abyssal regions of deep water, the crustal blocks being carried forward by the flow of the plastic region beneath. The formation or widening of these deeps cannot have greatly preceded the drift towards them, which seems to have culminated in Tertiary times. From what has been stated, there would seem to be reason to suppose that the development of the oceanic deep on the north-west of the British Isles was of a later date than that on the south-west.

The doctrine of the balance or "isostasy" of different areas of the earth's surface, which now seems to be firmly established, requires that the continents should be composed of lighter materials than the floor of the deep sea. The former consist mainly of granite (including the foliated granite more usually described as granitoid gneiss) and of sedimentary rocks which, though widespread at the surface, form only a comparatively small part of the whole. These are together conveniently referred to as sial. The ocean-beds must, on the other hand, be composed of heavier rocks made up of the silicates of iron, manganese, magnesium, and

¹ From the presidential address delivered to the Geological Society of London at the anniversary meeting on February 20.

calcium—the *sima* of Suess. This conclusion is confirmed by the greater "magnetic permeability" of the ocean-floor compared with the continents, indicating in the former the presence of ferrous oxide.²

The distinction between *sial* and *sima* appears to be the result of a primeval magmatic differentiation of the outer zones of the earth into a lighter acid portion consisting mainly of silica with alumina, the alkalies, and much water and other volatile constituents—that is to say, the typical magma of acid rocks such as granites and rhyolites—and a heavier basic portion corresponding to the magmas of dolerites and basalts, passing doubtless below into that of the still more basic peridotites.

There seems to be no doubt that Suess was right in supposing that the *sima* extends everywhere below the *sial* of the continents. There is, however, considerable difference of opinion as to the thickness of the continental *sial*. Wegener³ supposes it to be so much as 63 miles (100 km.). This is founded largely on Hayford's level of isostatic equilibrium or uniform density, which he placed at a depth of 71 miles (114 km.). It was afterwards reduced by Bowie to 60 miles (96 km.), which, however, appears to represent the depth of the *sial* forming the downward extending folds of the Rocky Mountains. Doubtless in the Himalayas it would be still greater, but in plains and plateaux the thickness may perhaps range from 9 to 40 miles (15 to 64 km.).⁴ It would depend on the altitude of the land and on the density of the *sial*. Nor is the depth to which the *sial* extends necessarily the same as that of the depth of uniform density. In the older parts of the continental shields the latter is probably considerably less than the former.

The idea that ocean-depths are the result of foundering is wholly opposed to the doctrine of isostasy, for it implies that the rocks which form the floor of the oceans are of the same composition as those of the neighbouring continents.

The only alternative is to conclude that the continental masses of *sial* can, under the action of continuously applied external forces, slowly drift through the *sima*, and that they have thus moved apart and left the ocean-deeps between them.

The magma of the granite of the *sial* must, on account of the large amount of water and other volatile constituents that it contained, have cooled to a comparatively low temperature, say 600° C., before it crystallised. These constituents were, however, eliminated and lost, so that it would thereafter require a much higher temperature to melt or even soften the rock, and the sedimentary constituents of the *sial* would (as a rule) prove equally refractory.

The basic rocks that constitute the *sima*, especially if they are rich in iron, are on the other hand less affected by the loss of volatile constituents. We may therefore expect that, at a temperature corresponding to comparatively moderate depths, they would become to some extent plastic.

The principle of isostasy appears in fact to depend on the circumstance that, given sufficient time, by no means very long from the geological point of view, the

sima acts as a whole as a fluid in which the *sial* floats, to use Airy's simile, like a log in water, or in Wegener's words, like ice-floes in the sea, although, it need scarcely be said, the viscosity of the *sima* (even at a fairly high temperature) is many thousands of times that of water. There is therefore nothing surprising in the blocks of *sial* making their way through the *sima*, accompanied, it may be, by crystallised *sima* adhering to their lower surfaces.

It is to the major fissures of the earth's crust, which are represented by the ocean-deeps, that we must look for the fundamental cause of igneous activity in regions of tension. As the fissure opens, the underlying *sima* magma will rise, in order to re-establish a condition of isostasy. This will be facilitated by the fact that the accompanying release of pressure will render the magma fluid, and at the same time cause it to expand. This expansion will be all the greater, on account of the volatile constituents in the magma. Its density will of course diminish correspondingly, and it will rise higher in the fissure than it would otherwise have done.

In the course of time, however, a large proportion of the volatile constituents will escape, crystallisation commence, and the density increase, so that the column will sink to a certain extent.⁵

Some idea of the depth from which the *sima* of ocean-deeps rises can be gathered from the temperature of igneous magmas. Dr. H. H. Thomas, from an examination of the metamorphism of the xenoliths in the Loch Scridain magma-reservoir, arrived at the conclusion that it was initiated at a temperature of nearly 1400° C.⁶ This figure rests on experiments with dry metals, and must, he thinks, be reduced, if the presence of water under pressure be taken into account. Some heat may have been lost while the magma was rising, and during the course of its intrusion; but there may have been a slight accession of temperature from oxidation or radio-activity. We may, however, assume for purposes of illustration that the temperature in the original position of the magma was in the neighbourhood of 1400° C.

According to the calculations of Prof. L. H. Adams, which appear to rest on a sound basis,⁷ this temperature would be ordinarily found at a depth of about 72 miles (115 km.). This actual figure is, at best, a conjectural estimate; but it would seem probable that some parts at least of the magma of igneous intrusions must come from a depth that cannot have been very much less. It would therefore seem that the formation of these major fissures presents the most probable means by which material from great depths has reached the neighbourhood of the surface, a conclusion which is of some importance in considering the source of the metalliferous ores.

Before the opening of a fissure, differentiation at such depths would be impossible, on account of the extreme viscosity of the magma under heavy pressure, but the release of pressure due to the opening of the fissure

² An incidental effect of the formation of rifts would be the lowering of the level of the sea. The area of the deeps lying below 15,000 feet (4573 metres) is about a third of that of the whole ocean. If, then, a tenth of these came into existence as rifts about the same time, in consequence of an average sinking of 7500 feet (2287 metres), the surface of the sea would be lowered by about 250 feet (76 metres). These figures are, of course, only intended to show that the effect would not be negligible.

³ Q. J. G. S., vol. 78 (1922), pp. 250-54, and "Island of Mull," *Mem. Geol. Surv.*, 1924, p. 278.

⁷ *Journ. Washington Acad. Sci.*, vol. 14 (1924), p. 468.

² A. Wegener. "The Origin of Continents and Oceans," 1924, pp. 32-33.
³ *Ibid.* p. 37.
⁴ H. S. Washington's estimate is from 15 to 20 km. (9 to 12½ miles), *Journ. Washington Acad. Sci.*, vol. 14 (1924), p. 437.

would result at once in an increase of fluidity. The first differentiation would be, in all probability, a repetition of the primordial process of differentiation into basic and acid magmas already mentioned, for the sima would appear to be capable of yielding another but smaller crop of an aqueous acid magma. This would be followed by further differentiation by crystallisation due to cooling as well as to loss of volatile constituents, with the result that ultimately a wide range of igneous rocks would be evolved.⁸ Before, however, differentiation had advanced very far, a series of lateral intrusions from the major fissures would have commenced. The flow of the deep sub-crustal sima towards the fissure would cause a temporary sinking of the adjoining crust, simultaneous with the rise of the magma in the fissure, with the result that, for a portion at least of the length of the column filling the fissure, the pressure of the magma would exceed that of the surrounding rock, so that intrusion would take place.

As differentiation proceeded in the intruded magma, the progress of the segregated acid magma would be retarded by local viscosity, caused by the loss of a portion of the volatile constituents and by cooling at the surface of contact with the adjoining rock. This would not be the case with the ultra-basic and basic magmas below it (which would form by far the greater portion of the whole), as they contain less volatile constituents, and are less dependent on them for their fluidity. The ultra-basic and basic magmas would, therefore, progress more rapidly than the acid magma. In so doing they would let down the still fluid portion of the acid magma above them until the latter reached the level of their flow. Here it would be protected

from loss of volatile constituents, and the temperature of the surrounding rock would by this time have become little less than that of the magma itself. The acid would therefore follow the basic magma in the channel of intrusion, a succession which corresponds very closely to the order of intrusion of plutonic magmas in the west of Scotland and at the Lizard.⁹

How far this lateral penetration will extend, and what form it will take, depend on the nature and structures of the rocks, and the earth-movements that may supervene. A magma may travel a considerable distance horizontally, or with a gentle inclination upwards—without any manifestation, other than the filling of fissures at right angles to the prevailing tension—until it meets with an obstacle, such as deeply-rooted mountain-folding, when it may form a tumefaction in the nature of a laccolith which will become a centre of igneous activity, and give rise to radiating and concentric structures as well as plutonic rock-masses, or it may well out in fissure-eruptions. Its progress and manifestations will be due partly to the hydraulic pressure to which it is subjected, and partly to the expansive force of its volatile constituents, and these will be assisted in some cases by faulting, bringing the magma into contact with rocks under less pressure, into which it will penetrate along joint- or fault-planes.

Of all these manifestations of igneous activity, it is the occurrence of parallel dykes that is usually the most widely extended, both in space and in time, and affords the most satisfactory evidence of the area throughout which a subterranean magma has spread—so far at least as it is accompanied by a prevalence of tensional conditions above it.

⁹ I have long advocated such an explanation of the order of intrusion of plutonic rocks in my lectures at the Imperial College of Science and Technology. I may add that the ultra-basic magma would move more rapidly than the basic: for, on account of the excess of the density of the basic magma over that of the adjoining rock, the maximum difference of pressure will occur below it.

(To be continued.)

⁸ That the first stage of the differentiation of igneous rock is into an acid and basic magma is, to my mind, abundantly proved by Dr W. A. Richardson and G. Sneesby's analysis of the frequency of igneous magmas of different silica percentages. This clearly shows two distinct peaks, one acid and the other basic, *Min. Mag.*, vol. 19 (1922), pp. 303-13.

The Nutrition of Cattle.

THE subject of the feeding of cattle assumes importance from the large part their products play in human dietaries. An accurate knowledge of their metabolism and nutritive requirements, apart from its intrinsic scientific interest, may lead both to more economical methods of feeding and at the same time to an improvement in the quality and quantity of the products, meat and milk, obtained from them. In this survey a brief account will be given of some recent work on the energy, protein and mineral requirements of these animals, with special reference to the production of milk in dairy cows.

The measurement of the energy requirement resolves itself into the problem of estimating the heat given out by the animal, since to maintain the body in equilibrium a similar amount of energy must be taken in in the food. The output of heat can be measured directly by placing the animal in a calorimeter, or chamber in which the heat emitted is measured by the amount absorbed by a current of cold water circulating through the chamber; the analysis of the ingoing and outgoing air at the same time will give the consumption of oxygen and output of carbon dioxide during the experimental period.

The method requires the use of elaborate apparatus, so that in practice the indirect method of determination of the heat output is more frequently employed. In this the output of carbon dioxide and consumption of oxygen are determined over a short period, and from these data, together with the value of the respiratory quotient, *i.e.* the ratio of carbon dioxide produced to oxygen consumed, a value can be found for the heat production which is sufficiently accurate for most purposes. The respiratory quotient conveys information as to the types of foodstuffs which are being oxidised in the body, and this information is essential since the heat produced varies according to the type of foodstuff, protein, fat or carbohydrate utilised.

The problem of estimating the heat output in the case of cattle has been still further simplified by W. W. Braman (*J. Biol. Chem.*, 1924, vol. 60, p. 79): the only data required are the output of carbon dioxide and the amount of food taken. In a large number of experiments he has found that the ratio heat/carbon dioxide is highest in starvation and falls steadily with increase in the amount of food eaten, the heat production increasing more slowly than the carbon dioxide formed.

The change is due to the fact that in starvation most of the heat produced comes from the oxidation of fat, which has a high calorie value, whereas the food is chiefly carbohydrate with a relatively low calorie value. These experiments enable an investigator, by estimating the carbon dioxide production and noting the food consumption, to determine the approximate heat output by applying the formula given by the author or by reading from the graph relating the ratio heat/carbon dioxide to the food consumption, which is approximately a straight line. The heat output thus calculated agrees closely with that actually observed in a calorimeter.

A more elaborate, but more accurate, indirect method of estimating the heat output of cows has been utilised by J. A. Fries, W. W. Braman, and D. C. Cochrane (U.S. Dept of Agric., Bull. No. 1281, 1924). The method depends on the fact that in an animal which is maintaining its weight, the heat output must equal the energy of the food actually utilised by the body during the experimental period. Of the food taken, some is not absorbed and some is excreted in an incompletely oxidised form. The digestibility of the food is usually estimated by taking the difference between the amount eaten and the amount excreted in the faeces, but the authors point out that in cattle, bacteria in the intestine play an important part in digestion. At the same time, one of the products of their fermentative action is a gas, methane, whilst the process itself is accompanied by an output of heat. The methane produced has been estimated in the respiration calorimeter, and the heat of fermentation from the ratio of methane to carbon dioxide in the products of fermentation. The results show that whereas the digestible portion of the food appears to be about 66 per cent. of that taken by estimation by the usual method, by taking account of the above two factors also, only about 50 per cent. of the food consumed is actually absorbed and available for energy and heat production. The actual energy of the food was determined directly by the bomb calorimeter, and thus the actual energy available to the body is known. Nearly all this energy is available for maintenance, growth (or increase of protein or fat in the body), work, and the production of milk, about 10 per cent. being lost in the processes of digestion and in the formation and elimination of the excreta. The authors have compared the heat production calculated from the available energy of the food with that actually observed during the same period in the respiration calorimeter and have obtained a very good agreement. The result indicates, in their opinion, that this method of "indirect calorimetry is sufficiently accurate for purposes of research in the feeding of farm animals."

Of the energy available to the body in the food, about half is required to maintain the body-weight constant: the remainder can be utilised for increase in body weight or for milk production. The data show that a larger proportion of the energy available is found as energy in the milk than in any increase of body weight; the process of milk formation appears to be more economical than that of body tissue and fat formation. The result suggests that the food materials are available directly for milk formation and do not have to become body tissue first and milk later. Of the available

energy, 90 per cent. or more can, under certain conditions, be utilised in milk production.

It is of course essential that the conditions of the experiment should be kept as constant as possible in different experiments. One factor which may introduce a disturbing element is the relative amount of time spent by the animal in the standing and lying positions. This subject has been considered in more detail by J. A. Fries and M. Kriss (*Amer. Journ. Physiol.*, 1924, vol. 71, p. 60). They found that allowance must be made for the taking up of heat by the floor on which the animal lies in the respiration calorimeter, this heat being afterwards given up when the animal stands, making the heat output of this period too high. The magnitude of this error can be ascertained by estimating the carbon dioxide output and assuming that the ratio heat/carbon dioxide is a constant. Making this allowance, it was found that the heat output of a 400 kgm. cow increased by about 25 calories per hour on standing. The authors recommend that the heat production be calculated to a standard day of twelve hours lying and twelve hours standing, so as to obtain uniformity in the expression of the results obtained by different observers.

It is of interest to note that in the later stages of gestation, a cow appears to require about 2 per cent. more food for maintenance than a non-pregnant animal of the same weight.

The utilisation of protein in milk production has been considered by J. A. Fries, W. W. Braman, and M. Kriss, and also more recently by E. B. Forbes and R. W. Swift (*Journ. of Dairy Science*, 1924, vol. 7, p. 11, and 1925, vol. 8, p. 15). The two sets of experiments agree fairly well in showing that in well-fed animals the utilisation of protein for milk production is about 40 per cent. of that available for this purpose (that is, the digestible protein of the food less that required for maintenance). With decrease in the protein intake, however, the former authors found that a larger proportion of the available protein, up to 85 per cent., became available for milk production, since the nitrogen excretion falls *pari passu* with the drop in nitrogen intake, whilst the nitrogen in the milk remains almost constant. With a higher percentage utilisation, however, the amount of milk produced tends to fall off, being increased again with increase in the protein intake. The optimum nitrogen intake was an amount of available nitrogen about 10 per cent. greater than the nitrogen found in the milk produced. The animals maintained their weight, whereas with a larger protein intake the animals gained in weight by the deposition of fat, together with an increased formation of body tissue. The fact that with low nitrogen intakes the quantity of milk produced tends to fall off in a cow producing a large amount daily, suggests that the level of optimum intake of nitrogen as regards the nitrogen of the milk is not the optimum level for the production of a large quantity of milk, which contains both fats and carbohydrates as well as protein, and therefore that the animals should be well fed, if the best results as regards milk production are to be obtained.

In addition to the proteins, fats and carbohydrates present in milk, account should also be taken of its vitamin and mineral content in estimating its quality. Ultimately these factors come from the food, in which

they should therefore be present, but the amounts passed into the milk may be greater than can be absorbed in the food, leading to a depletion of the animal's own stores. This appears to occur especially in the case of the calcium of the milk. During liberal milk production on winter foodstuffs there may be a definite loss of calcium from the body; on fresh foodstuffs this loss is less or may be absent (E. B. Forbes, Washington Government Printing Office, 1924). This effect is quite probably to be related to different amounts of vitamin A present in the dry and fresh green foodstuffs, but it seems to be clear that the cow should be encouraged to store as much calcium as possible in her body during her dry periods by the giving of calcium, for example, in the form of bone

meal, in addition to an adequate supply of fresh green foodstuffs. It is possible also that the addition of sodium phosphate to a dried ration may increase the milk yield after parturition, suggesting that this food may be deficient not only in calcium but also in phosphorus, or that the availability of these elements present in the food is impaired by a deficiency in the fat-soluble vitamin A.

The general result of all these investigations is that a dairy cow should be fed on an abundance of fresh green food, containing a supply of protein, etc., which is sufficient to maintain both the quantity of the milk produced at a high level as well as its protein, mineral and vitamin content. If this be done, the supply of energy will certainly be adequate also.

Current Topics and Events.

SCIENTIFIC aspects of national life were honoured by the attention and interest given to them on two occasions last week by the King and Queen. On the afternoon of Wednesday, July 22, their Majesties visited the Royal Society and examined with much interest many of the exhibits arranged for the annual conversazione of the Society held on the evening of the same day. They were also present at a lantern lecture by Mr. F. E. Smith, Director of Research at the Admiralty, upon the subject of navigational devices. On Thursday, July 23, the King and Queen visited the Royal Observatory, Greenwich, in connexion with the celebration of the 250th anniversary of the foundation of the Observatory. They were received in the Octagon Room by Sir Frank Dyson and conducted round the Observatory. A number of members of the Board of Visitors and delegates from abroad of the International Astronomical Union had the honour of being presented to their Majesties.

A SLIGHT anticipation of dates was made in the celebration of the 250th anniversary of the Royal Observatory, Greenwich, on July 23, in view of the presence in England of the large body of foreign astronomers who had come for the meeting of the International Astronomical Union at Cambridge. Actually the foundation stone of the Observatory was not laid until August 10, 1675, and Flamsteed did not come into residence until July 1676. However, an exact adherence to dates is seldom possible in these commemorations, and the circumstances amply justified the anticipation. The celebration was honoured by the presence of the King and Queen, this being the second visit of a British sovereign to the Observatory since its foundation; the previous one was by George III. Although Charles II. showed so much interest in its foundation, there is no record extant of his having actually visited it. Their Majesties were conducted round the principal domes by the Astronomer-Royal, and later expressed the interest and pleasure that they had derived from the visit. It may be well to remind younger readers that our "Sailor King" has been through the complete course of a naval officer, and commanded a destroyer, so that he has a full knowledge of nautical astronomy. The prime object of the foundation of the Observatory

was to aid navigation, this end has been kept in view up to the present, as we see in the rating of chronometers, the dropping of time-balls at Greenwich, Deal and elsewhere, and the continued observation of the positions and motions of sun, moon and fundamental stars. The evolution of the chronometer could be traced by the visitors, since the three earliest timepieces of Harrison were exhibited. Two of them have lately been restored, and were actually going, so that they could be compared with a large number of modern chronometers.

THE sudden death on July 26, at the age of sixty-five years, of Mr. W. J. Bryan, orator, politician and Fundamentalist, has come as a shock to all who followed the course of the trial at Dayton, Tennessee, of Mr. J. T. Scopes, who was convicted of breaking the State law against teaching the truth of evolutionary theory. Mr. Bryan conducted the prosecution ably, but during his examination by the defence, he made some remarkable statements as to the precise dating of events in the Biblical record. The Flood was fixed as probably having taken place in 2348 B.C., while the confusion of tongues at the Tower of Babel was assigned to 2230 B.C. Mr. Bryan conceded that the six days of creation must be regarded as periods of time. A further admission that the creation might have continued for millions of years may perhaps open the way to some sort of accommodation with geological evidence; it might even admit of an adjustment with the one hundred and thirty thousand years or so which at least seem to be demanded for man's existence on this earth by the evidence of the stone implements of Lower Palæolithic Age—to say nothing of those of earlier date. In putting to Mr. Bryan the evidence for the existence of civilisation in China before the Bible creation 6000 years ago, counsel was perhaps on somewhat uncertain ground, although the Shu-king begins with a record of the days of Yaou (2355 B.C.) and Shun, who brought to a close the second patriarchal dynasty of China, founded by Foh-hi in the year 2943 B.C. On the other hand, Mr. Bryan's fellow-countryman, Mr. Pumpelly, estimated that the beginnings of the neolithic stratum which he excavated at Anau in Turkestan dated back somewhat before 8000 B.C.

ALTHOUGH archaeologists are inclined to regard Mr. Pumpelly's dating at Anau as too early, and display the same hesitation in accepting the very high dating of M. de Morgan for the early civilisation he found at Susa, the results of recent excavations in Mesopotamia are of considerable interest in relation to the question of early datings. The work both at Kish and at Ur and the neighbouring site of Tel el-Obeid in the last two or three years has considerably extended the period of antiquity of which the dating may be considered to have been fixed with a reasonable degree of accuracy. At Kish, for example, an inscription of Lugul-ud, king of Kish prior to 3100 B.C., has been discovered, and below the floor of the building in which it was found lie 15 feet of debris, which on a conservative estimate would place the early occupation so far back as 4500 to 5000 B.C. At Tel el-Obeid a marble socket of a gate has been found which bears the inscription of a king of the first dynasty at Ur. According to Babylonian tradition, this dynasty was the third to rule after the Flood. This discovery vindicates the existence of the dynasty, which had hitherto been regarded as mythical like its two predecessors, and if the dead reckoning estimate of its beginning in 4600 B.C. is too high, 4000 B.C. or 3900 would be a not unreasonable date. In Egypt, as is well known, astronomical data are available, though gaps in the records give some uncertainty to early dates. On the lowest estimate, however, the accession of Menes, the first king of the First Dynasty, is assigned to 3400 B.C., while the calendar was introduced in 4241 B.C.

In a speech delivered at a luncheon of the British Optical Instrument Manufacturers' Association on Thursday, July 23, Mr. F. Twyman, the president, gave an instructive and encouraging review of the present technical condition of the optical instrument industry of Great Britain. It is well known that the industry has suffered enormously during the financial and commercial decline of the past few years. It is not so well known, however, that these years have been for the industry a period of experiment and development, of prolonged and successful effort towards improving its products, inventing and putting new products on the market, and increasing its equipment for producing. The experimental and research work carried out continuously by members of the industry has resulted not only in an increase in the range of products, but also in developments of real scientific importance. From many examples quoted, it would seem probable that most of the research of the world, in certain fields of prime importance in modern physics, is being done with British-made instruments. The growing use of optical instruments for the control of industrial processes, and for maintaining a high and uniform standard of quality in the productions of important industries, has undoubtedly been encouraged by the fact that these industries have been able to obtain from British optical firms suitable instruments, often very complex and designed with great inventive ability to achieve the particular end desired. The technical advances and

achievements in regard to the design and production of optical instruments, enumerated by Mr. Twyman, give evidence that the industry is active in invention and development and in the application of the results of scientific research conducted by it or on its behalf. The result is seen in its ever-improving position in the race for technical supremacy.

A MEETING, called by the Optical Society to consider the desirability of arranging an Optical Convention in 1926, was held at the Royal Society of Arts on Tuesday, July 21. Sir Herbert Jackson presided, and there were present representatives of all branches of the optical and scientific instrument industry, together with representatives of cognate scientific and technical societies, and others interested in the theory and practice of optical science and in the use of optical instruments. The chairman intimated that the object of the proposed Convention was to bring before the notice of the scientific and general public the many and important developments which had taken place in recent years in British optical apparatus and instruments, and to show that the products of the optical glass industry and the optical instrument industry of Great Britain were well able to compete with those of foreign competitors. It was for the manufacturers to decide whether the time was opportune for holding such a convention. Several of those present spoke in favour of the proposal, and it was resolved that a British Optical Convention be held at the Imperial College of Science and Technology, South Kensington, in July 1926, and that a guarantee fund of 2000*l.* be raised, if possible, before October 1, 1925. It was announced that the Council of the Optical Society had already agreed to contribute a sum of 200*l.* towards such a fund. Thereafter, a general committee consisting of those present was formed, and an executive committee nominated, with powers to make the necessary arrangements. Detailed proposals will be published with regard to the scope and scheme of the Convention as soon as the executive committee has considered the various matters involved.

THE second of the annual conversazioni of the Royal Society was held in the Society's rooms on July 22. The majority of the exhibits arranged for the occasion were also shown at the first conversazione (NATURE, May 23, p. 819). Among the fresh exhibits were six models of early locomotive engines, pieces of apparatus used by Sir William and Sir John Herschel and a replica of an early Egyptian astronomical instrument. This instrument, the "Merkhet" of the Egyptians, and the "*ἀπολόγιον*" of the Greeks, was used to lay out a meridian line and to note the meridian passage of stars for determining the time in connexion with temple ceremonies. The original in Berlin dates from about 700 B.C., but the instrument was in use very much earlier. These exhibits were shown by the Science Museum. Mr. W. Bateson and Mr. R. J. Chittenden (John Innes Horticultural Institution) showed examples of root-cuttings and plant-chimæras in *Pelargonium*. Plants raised from buds formed on roots may differ from those

raised from shoots, demonstrating the existence of an inner component. The plant may be (1) male only, (2) female only, (3) sterile, whereas the inner component is in each a normal hermaphrodite. The distinction is probably in epidermis alone. Zonal *Pelargoniums* raised by cross-fertilisation between green and albino tissues show the artificial formation of chimæras. Rothamsted Experimental Station had an exhibit illustrating the inoculation of lucerne with nitrogen-fixing bacteria (Mr. H. G. Thornton and Prof. N. Gangulee). A motile stage has been discovered in the life-cycle of *Bacillus radicicola*, the organism forming nodules on the roots of leguminous plants within which nitrogen is collected and utilised by the plant. This stage is connected with the spread of the bacteria through soil. The results have been applied, with some success, to the practical problem of inoculating the lucerne crop. The National Physical Laboratory showed a Guild colorimeter for fundamental investigations in colour vision (Mr. T. Smith). Light from a single source, after passing through gelatine filters of three selected colours arranged symmetrically about the circumference of a circle, is brought to a common axis by a rotating prism. The mixture thus obtained is presented side by side with the colour to be measured by means of a photometric cube.

At the Conference of Women in Science, Industry and Commerce, held at the British Empire Exhibition on July 15-18, Miss C. U. Kerr read a paper on the effect of welfare work upon health and efficiency. Miss Kerr outlined the history of the welfare movement and pointed out that the earliest experiments in welfare work were initiated in engineering factories. The chief branches of welfare were considered and a special plea put forward for the adequate provision of food for the workers. Many firms are still without canteens, and those which do have them often fail to see that the food is interesting and appetising. The proper selection of workers was discussed and an interesting suggestion made that many operations could be well performed by people not of robust physique, provided that the conditions were good. The advantage to a delicate person who finds his job and knows he can do it well cannot be calculated only by his efficiency at work; the mental effect is probably the cause of the improvement related by the writer in connexion with a tobacco factory. One would like to see the engineering metaphor disappear from these discussions. The writer of this paper quotes the phrase "Human Engineering" as an apt description of welfare work and calls "food for the producers," "fuel for the human machines." These phrases stand for a mechanical interpretation of life which has been, and still is, the cause of no little trouble in the industrial world. A machine is a means to an end: Can that be true of a human being?

MR. GOYDER, of Mill Hill School, has maintained two-way radio communication with the leader of the MacMillan Expedition in the Arctic. When communication was first established on July 18,

the *Bowdoin*, with Captain MacMillan on board, was at Hopedale, Labrador, but on July 24 she was crossing the Arctic Circle. The two ships, the *Peary* and the *Bowdoin*, are proceeding to their base at Etah in Greenland, and it is hoped to make an aeroplane base at Cape Thomas Hubbard in Axel Heiberg Land. Mr. Goyder works with a 250-watt Mullan valve on a wave-length of 40 metres. He only uses a single wire Hertz aerial, but he receives on a special circuit devised by Mr. Reinartz, who operates the radio apparatus on the *Bowdoin*. The messages are received best between midnight and six o'clock in the morning. Mr. Goyder has himself transmitted to America several messages from the explorers to their friends. It will be remembered that he was the first to maintain two-way communication between Great Britain and New Zealand. Mr. Goyder is to be congratulated on his success, which will raise the status of British amateur radio-telegraphy.

At the annual general meeting of the Marconi International Marine Communication Co., Ltd., held on July 24, Senator Marconi gave an interesting sketch of the lines on which radio signalling is developing on board ship. During the past two years, numerous experiments have been made to find out how far radio telephony is desirable and practicable in the mercantile marine. Trials were made in trawlers as well as in liners, both between ships and between ships and shore. The results obtained prove that there is no technical difficulty in the way of accomplishing a satisfactory service of duplex radio telephony between ship and ship when they are on the high seas and away from the areas of congested radio-telegraphic traffic. In one instance a range of nearly 400 miles was covered. If a demand arises by ship's commanders and passengers, it can easily be met. There is, however, no likelihood at present of radio telegraphy at sea being superseded by radio telephony. When financial matters are less stringent, it is probable that shipowners with the collaboration of the Post Office will give facilities for conversation between passengers and shore stations. The Board of Trade has recently made a regulation under which the use of a radio automatic calling device is made compulsory for all ocean-going vessels the crews of which number less than 50. Shipowners, however, are appealing against this regulation as they consider that the present time is inopportune for increasing their financial burdens. Senator Marconi said that there has been a rapid increase in the demand for his company's direction finder, which has proved of great value to navigation, especially in foggy and rainy weather. A ship fitted with this device is able to assist other ships in its neighbourhood by sending them their positions.

SINCE the War, France has paid particular attention to securing its economic independence of other nations. Great attention has therefore been paid to developing "la houille blanche," or water power, so called to distinguish it from "la houille noire," or

coal, from which thermal power is developed. As the total possible power output of the mountain torrents of the Pyrenees and the Alps and of the Rhone, the Garonne, and the Rhine is several times greater than the power equivalent of the present French output of coal, there is plenty of scope for industrial development. In connexion with the present exhibition of "La Houille Blanche" at Grenoble (May–November) the *Revue Scientifique* has published an excellent historical and industrial account of the state of the art of hydro-electrics. It is interesting to remember that Fourneyron in 1837 installed at Saint-Blasien in the Black Forest small water turbines 31 cm. in diameter, producing 60 horse power, the fall being 114 metres. The efficiency of the machines was no less than 80 per cent., which is quite comparable with that of the best modern machines. In the historical survey an account is given of the work in hydrodynamics done by Pascal, D'Alembert, Lagrange, Laplace, Poisson, Cauchy, and others down to Poncelet and Girard. Interesting portraits are given of the French scientific workers. In the technological section illustrations are given of the chief steam- and water-power stations in France, and methods are indicated for accelerating the development of industry by distributing electric power over wide areas. H. Parodi, the engineer to the Compagnie d'Orléans, contributes a thoughtful paper on the different policies adopted by the various countries of the world with regard to railways operated by electric traction, and more particularly those which utilise water power through the medium of electricity. The curves he gives indicate clearly when electric traction becomes a commercial proposition.

THE River Pollution Committee of the Ministry of Agriculture and Fisheries, having learned that the impression prevails in many quarters that the Committee is antagonistic to the use of tar in the preparation of road surfaces, is anxious to correct this impression. The Committee is concerned solely with the question of river pollution from the point of view of the fishery interest. The constituents of tar, if they find access to a river, are most injurious to fish and their food, and the Committee earnestly advocates the avoidance of the use on any road, the washings from which are likely to find their way directly into a stream, of any road dressing containing tar or tar products. Washings from bituminous surfaces are, however, innocuous to fish and their food, and the Committee has advocated the use on roads in proximity to streams of bituminous dressings. Obviously, the roads with which the Committee is concerned constitute only a small fraction of the total roads of the country. The Committee's policy has been solely to urge upon all road authorities that care should be taken to avoid the use of tar at what are the danger points from the point of view of pollution. The Committee has examined a number of preparations for road-surfacing, and is prepared, if consulted by road authorities or other persons concerned, to advise them as to the suitability for use in proximity to streams of such preparations as they have examined.

HEATHFIELD HALL, Watt's residence at Birmingham, where he lived from 1769 until his death, is now in course of being demolished to make way for new buildings which are to be erected on what was once his estate. Fortunately, however, all the machines, tools, benches, etc., from Watt's workshop have been presented by Major Gibson Watt to the Science Museum at South Kensington, where on the ground floor of the new building, not far from three of the engines which were built by the firm of Boulton and Watt between 1777 and 1797, an accurate reproduction of James Watt's workshop has just been completed. The present owners have generously presented the door, windows, flooring, etc., of the old room, so that it has been possible to produce a replica of the old attic, and in it to arrange the contents as they were at the time of Watt's death. The two copying sculpture machines, the lathe, and benches, boxes of tools, tables, etc., take up too much space for the public to circulate in the room, but a large plate glass window in one of the walls allows the workshop and its contents to be seen readily.

THE following officers of the Institution of Electrical Engineers have been elected:—*President*, Mr. R. A. Chattock; *Vice-Presidents*, Lieut.-Col. K. Edgcumbe, Prof. W. M. Thornton; *Hon. Treasurer*, Mr. P. D. Tuckett.

AT the annual general meeting of the Royal Society of New South Wales, held on May 6, the following officers were elected:—*President*, Prof. R. D. Watt, *Vice-Presidents*, Mr. J. Nangle, Mr. E. C. Andrews, Mr. C. A. Sussmilch, and Dr. C. Anderson; *Hon. Treasurer*, Prof. H. G. Chapman; *Hon. Secretaries*, Mr. R. H. Cambage and Dr. R. Greig-Smith.

SIR ERNEST and LADY RUTHERFORD left Great Britain for Australia and New Zealand on July 25, on the s.s. *Ascanius*, bound for Adelaide. While their main object is to visit their parents and relatives in New Zealand, Sir Ernest has also promised to deliver lectures on aspects of modern physics in some of the chief cities of Australia and New Zealand. They hope to return to England in January 1926.

AT the annual meeting of the Museums Association held at Exeter on July 7, the following resolution was passed:—"That the Museums Association desires to place on record its opinion that the present reckless destruction of animal and plant life by collectors and others will, if continued, result in a deplorable loss to posterity." Mr. J. Bailey, late of the Circulating Department of the Victoria and Albert Museum, London, was elected president of the Association for the year 1925–26. The next conference will be held at Bournemouth in July 1926.

PROF. A. A. MICHELSON, professor of physics in the University of Chicago, has been appointed to the first of the distinguished service professorships which have been established in that University. These professorships form part of a development scheme which, we learn from *Science*, has been instituted with the view of raising a new endowment fund of 6,000,000 dollars. Special efforts were made to obtain funds

in sums of 200,000 dollars, the incomes from which would be devoted to professorships such as that now conferred on Prof. Michelson. The present professorship is due to the generosity of Mr. M. A. Ryerson, of Chicago, formerly president of the board of trustees and donor of the Ryerson Physical Laboratory of the University.

THE autumn meeting of the Institute of Metals is to be held at Glasgow on September 1-4, under the presidency of Prof. T. Turner, Feeney professor of metallurgy in the University of Birmingham. The proceedings commence with the fourth autumn lecture, by Sir John Dewrance, who will take as his subject "Education, Research and Standardisation." Sixteen papers on various aspects of the constitution and properties of metals and alloys are to be submitted for discussion at the meeting. The lighter side of the programme announces visits to works and places of interest in the neighbourhood of Glasgow, and special arrangements are being made for the entertainment of the ladies present. Railway vouchers enabling members of the Institute and their friends to purchase return railway tickets to Glasgow at the rate of a single fare and a third can be obtained from the secretary of the Institute of Metals, 36 Victoria Street, London, S.W.1.

THE Council of the Institution of Electrical Engineers, which took an important part in founding the Society of Radiographers in the year 1920, and, under that Society's constitution, has up to now nominated six out of the eighteen members of the Society's Council, has withdrawn its nominees and terminated the Institution's connexion with the Society. This action has been taken because the majority of the Council of the Society of Radiographers has resolved upon certain alterations of the Society's articles, with which the Council of the Institution of Electrical Engineers is in entire disagreement, as in the Council's opinion these alterations will materially lower the professional status of non-medically qualified radiographers.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: An advisory agricultural economist at the Seale-Hayne Agricultural College, Newton Abbot—The Secretary and Bursar (August 4). A second assistant in botany in the University of Aberdeen—The Secretary (August 19). An assistant lecturer in physics at the University College of Wales, Aberystwyth—The Secretary (August 30). A laboratory assistant for the Veterinary Research Department of the Government of Uganda—The Crown Agents for the Colonies, 4 Millbank, Westminster, S.W.1, quoting M13/800

Our Astronomical Column.

THE JULIAN DAY—A matter that excited much interest was settled by the International Astronomical Union, after a long discussion, by a considerable majority. When it was decided that the astronomical day should begin at midnight, instead of noon, a diversity of view was manifested as to whether the Julian day should follow suit, or begin at noon, as heretofore. Speaking broadly, the former view was held in America, the latter in Europe. The matter is of especial importance for variable-star observers, since it has for long been the custom to use the Julian day both for the elements of these and for recording observations.

It was further pointed out that the whole point of the institution of the Julian day system was to have a method of recording time that should be independent of all changes of style or calendar changes, and that once established such a system should not be lightly broken. It was, indeed, admitted that there had been a change of two hours since its institution, its beginning was then noon at Alexandria, afterwards altered to Greenwich noon. However, a change of two hours applied to comparatively rough early observations is of little moment compared with a change of twelve hours in accurate modern observations. Many of the Americans, including Prof. Shapley, admitted the force of these arguments, and supported the retention of the noon beginning, which was afterwards confirmed by the Union as a whole.

An endeavour was also made to agree on a name for the new astronomical day that begins at Greenwich midnight. A very large section expressed disapproval of continuing to use the phrase Greenwich Mean Time for the new system, but no alternative was found that commanded general assent, it was agreed to leave the matter open, as being comparatively unimportant, provided one made clear what time-system one was

using. The title "Universal Time" met with most support, and the Astronomer-Royal said he would endeavour to get this name inserted in the Nautical Almanac as a second title, Greenwich Mean Time continuing to be the first title.

PERTURBATIONS OF MINOR PLANET 944, HIDALGO — Discovered by Dr. Baade of Bergedorf in 1920, Hidalgo is one of the most interesting of the minor planets, being near the orbit of Mars when in perihelion, and near that of Saturn when in aphelion. Its period, $13\frac{1}{2}$ years, does not differ greatly from that of Jupiter, its orbit is inclined to the ecliptic at the high angle of 43° , the greatest of any minor planet. However, its passage of the descending node takes place not more than half a unit from Jupiter's orbit, and the question of the perturbations by the latter is of interest. Mr. K. Jantzen investigates the secular perturbations by Jupiter in Bulletin of Vilno Observatory, No. 5, using the method given by Hills in vol. 1 of the Amer. Ephem. Papers. The circle of eccentric anomaly was divided into 192 parts, this large number being necessary owing to the near approach to Jupiter's orbit, which occurs when $E = 83^\circ$.

The final values of the secular perturbations of the elements are, $e + 14''.4$, $i - 16''.2$, $\Omega - 26''.5$, $\pi - 65''.3$, $L + 57''.6$. The method of special perturbations would have to be used at the time of a near approach of the two bodies, there was actually a fairly near approach (less than an astronomical unit) in 1922. This was probably the closest in the last century or thereabouts.

Some authorities are inclined to rank this body as a comet rather than a planet. It seems, however, better to limit the term comet to bodies showing nebulousity. Hidalgo always appeared stellar.

Research Items.

THE "LOST CITY OF NEVADA."—Dr. M. R. Harrington, of the Museum of the American Indian, Heye Foundation, contributes to the *Scientific American* for July an account of the excavation of the Pueblo Grande de Nevada, also known as the "Lost City," which began in November last. This settlement is probably one of the oldest in North America, north of Mexico, antedating the cliff dwellings of New Mexico and Arizona. It lies scattered along the banks of the Muddy River over a distance of five or six miles, with a greatest breadth of a mile. About thirty houses have been uncovered. On the floors and in graves have been found implements of bone and stone, pottery and ornaments of shell and turquoise. The inhabitants gathered wild natural products, but also farmed, raising corn, beans and squashes. They had no domesticated animals except the dog, and hunted deer, mountain sheep, and the jack rabbit, though the bones of game animals are not numerous. Considerable progress had been made in weaving and dyeing. The pottery has a general resemblance to Pueblo but belongs to an early period, while the dwellings are of the primitive type, consisting of an oval pit two or three feet deep, which must have had a superstructure of poles and matting. The development in type of the dwelling shows that Pueblo Grande belongs to the close of the pre-Pueblo and the beginning of the Pueblo period.

DECORATIVE DESIGNS ON CARVED WOODEN FOOD-BOWLS, PORTUGUESE EAST AFRICA.—Some interesting notes on the origin of the decorations on carved wooden food-bowls among the Va-Lenge and Va-Chopi of Portuguese East Africa are contributed by Miss E. Dora Eady to Vol. 11, Part 2, of the *Annals of the Transvaal Museum*. Both peoples have an elaborate system of hair-dressing, varying with the great social events and crises of their life. The food-bowls, generally circular in shape, when turned upside down are regarded as human heads, and the little platings of the hair which are grouped together in a triangular shape are reproduced on them as incised triangles. A notched arrangement, forming a series of lozenges at the base of each triangle, is also copied from the hair, though on the bowls the place of the lozenge is sometimes taken by a chevron. The absence of the chevron or lozenge on the bowl pattern represents the hair of widows and uninitiated girls. If the lozenge is very small it indicates an initiated girl or one ready for marriage. The chevron means that the woman's husband is ill, some think recently deceased. A hair-parting encircling the head is also reproduced on the bowl, where by some it is said to represent the line of scalping or decapitation followed formerly when the Va-Chopi were head-hunters.

AMERICAN OAKS.—The twentieth volume of the *Memoirs of the National Academy of Sciences (U.S.A.)* is devoted to a monograph by Dr. Wm. Trelease of the oaks inhabiting the New World. Although the oaks of the United States and Canada have been reviewed from time to time by Sargent and other American botanists, no such comprehensive work as this, which deals with the genus *Quercus* as represented on the entire continent, has appeared before. The region occupied by the American oaks extends from Canada southwards to the Columbian Andes and Cuba, the greatest aggregation of types occurring in the highlands of Mexico. Dr. Trelease divides them into three main sections, namely, the white oaks (*Leucobalanus*), the red oaks (*Erythrobalanus*), and a small intermediate oak (*Protobalanus*).

These sections are subdivided into numerous groups, for each of which a detailed general description is provided, the individual species being differentiated by one or more leading characters only; but new species, of which the author has made a considerable number, are described in full. The geographical range of each group and species is defined, and an adequate, though not necessarily complete, synonymy is given. The real value of such a work as this can only be appreciated of course by long and continued use, but there can be no doubt that it has simplified for the student the very intricate and difficult problem of the American oaks, and brought into convenient compass a vast amount of exact information concerning them. The introductory essay, dealing with the history of the genus, details of structure in stem, leaf, flower, and fruit, taxonomy, geographical distribution, hybridity, and the fossil botany of oaks, is admirably written. For the purpose of preparing this monograph, which is illustrated by 420 plates, the author has studied the material in all the great herbaria of the world.

LEAF SHAPE.—The factors controlling leaf shape are undoubtedly various and differ under different conditions, but Dr. W. H. Pearsall and Miss Alice M. Hanby seem to throw some light upon them in the experimental study of *Potamogeton perfoliatus*, which they report upon in the *New Phytologist*, vol. 24, No. 2. Using Pond's method of enclosing the root system in one culture solution and the submerged shoot system in another, they are able to analyse the effect of different solutions upon growth. Their results make clear the great importance of the ratio of calcium to potassium and sodium ions in the solution upon the relative length and breadth of the leaf, whilst their analysis of this difference shows it must be attributed to a different activity of the meristem when growing in solutions which vary in the relative proportions of these ions. Their conclusion is that with this variable species, changes in leaf form are usually determined under natural conditions by the calcium content of the soil and to a less extent by light.

ON AMMONITES VIA NAUTILUS.—A paper by Martin Schmidt entitled "Ammonitenstudien" (*Fortschr. Geol. und Paläontol.*, Hft 10) covers a far wider field than its title would indicate. The first portion, illustrated by an excellent plate, treats of new and little-known Ammonites from the Schwabian Lower Lias. The second portion contains a general summary of what is known concerning Nautilus, including a histological section by Max Rautner, followed by an attempt to apply that knowledge to the study of the Ammonites. The author favours the idea that the Ammonites were plankton feeders and their successive modifications and destruction were entailed by the altered habits and extinction of their food.

PALÆONTOLOGICAL HISTOLOGY.—The Nigerian Government has published (Geological Survey of Nigeria, Occasional Paper No. 2) an account by Baron Nopcsa of some fragments of fossil reptiles from Sokoto. These are for the most part Crocodilian or Deinosaurian, but are too fragmentary to yield much information beyond the suggestion that the beds in which they occur are Lower Eocene in age. The chief interest in the paper lies in the application of histological methods to palæontology, whereby it seems possible from the structure of the Haversian canals to distinguish Crocodilia from Deinosauria.

Further investigation along these lines should lead to interesting results.

ARCHÆOPTERYX.—Dr. Petronievics has continued his investigations on the genus *Archæopteryx*, which he began upon the specimen in the British Museum, by a study of the example in Berlin. From a comparison of the two he comes to the conclusion that, so far from being the same species, they represent two different sub-classes of birds. For the British Museum specimen he retains the name *Archæopteryx*, and calls the Berlin one *Archæornis*. The first is considered to be a primitive ratite and the second a primitive carinate. In general *Archæopteryx* shows the more primitive characters of the two. The author comes to conclusions, which are certainly not those of the text-book, that the ancestor of birds is to be sought in a primitive group of the *Lacertilia* and that the resemblances which have led investigators to see some affinity between birds and the *Deinosaurs* are to be interpreted as due to convergence. The paper is published in the *Annales Géologiques de la Péninsule Balkanique*, vol. 8, 1925.

THE MINERAL IDDINGSITE.—The red-brown alteration product of olivine known as iddingsite has become very familiar to petrologists during the last thirty years, but hitherto its nature and properties have been only vaguely realised. C. S. Ross and E. V. Shannon have now presented a careful study of the material in the *Proc. U.S. Nat. Museum*, vol. 67, No. 2579, 1925. They conclude that iddingsite is not a product of weathering, but is the result of metasomatic processes associated with the later stages of a cooling magma. It forms from olivine soon after the close of crystallisation under conditions of oxidation and hydration: MgO is abstracted, FeO is oxidised to Fe_2O_3 and water is added; and the resulting product has a formula of the type $\text{MgO} \cdot \text{Fe}_2\text{O}_3 \cdot 3\text{SiO}_2 \cdot 4\text{H}_2\text{O}$. The optical properties are distinct and different from those of any other described mineral, including serpentine, which differs in mode of origin, chemical composition, and physical properties. Iddingsite is therefore regarded as a definite mineral species.

THE GEOLOGY OF NORTH LONDON.—Under this title the Geological Survey of Great Britain issues an explanation of one-inch Sheet 256 England, by C. E. N. Bromehead, with contributions by H. G. Dines and J. Pringle. The area comprised includes London north of the Thames, and the surrounding country as far north as Watford and Enfield. The whole ground has now been surveyed on the six-inch scale, but a large proportion of the area has been built over and more is still "under development," so that there are few open sections available for study. Save for brief allusion to the older rocks the formations dealt with range from the Upper Chalk to the Alluvial. Despite the evidence of palæontology, the Glacial deposits are still placed at the beginning instead of the close of the Pleistocene period, and though many of the Pleistocene mammalia are duly chronicled, we miss all reference to *Rhinoceros tichorhinus*, a fine skull of which, now in the British Museum (Natural History), was found at Perivale in the Brent valley, and recorded so far back as 1913.

PERIODIC CHEMICAL CHANGES.—A further paper on periodic chemical phenomena by E. S. Hedges and J. E. Myers appears in the *Journal of the Chemical Society* for May. Typical periodic reactions have now been investigated from an electrochemical point of view. In the case of activated metallic couples dissolving in hydrochloric acid or ammonium chloride,

the potential difference between the couple as a whole and the solution, and that between the two components of the couple, undergo periodic fluctuations which synchronise with the periodic evolution of gas. A potential difference exists between the active and inactive forms of a metal. The periodic deposition and dissolution of iron on magnesium in an acid solution is investigated, together with a few other similar cases. A corresponding oscillation of the electropotential occurs, and often there is a periodic evolution of hydrogen. Examples are given of "autoperiodic" reactions, where one electrode serves both as the reacting metal and as the activating agent. The results are correlated with those of previously published investigations.

A VACUUM THERMO-ELEMENT.—A number of instruments have recently been described for spectroscopic observations, and for the direct measurement of the radiation of the stars, in which a thermo-element, consisting of two thin wires of different metals soldered together with a small receiving plate attached to the junction, is mounted in a vacuum. Messrs. W. J. H. Moll and H. C. Burger criticise this arrangement in the *Zeitschrift für Physik* of June 5, pointing out that it is slow in action, owing to the mass of solder necessarily added at the junction. They describe a method in which the edges of two plates of constantan and manganin a few millimetres thick are soldered together with silver, and then rolled out in the direction of the soldered junction to about 1μ thickness. The result is a long thin ribbon of foil, one-half of constantan and the other of manganin, soldered together along the length of the ribbon by a thin line of silver. Narrow strips at right angles to the length can be cut from this, and it is even possible by etching to obtain a small receiving disc about the junction, with narrow strips of foil on either side, which can be soldered to the supporting wires. Such an element can be mounted in an evacuated bulb of glass or quartz, which can be sealed off permanently; and when this is enclosed in a double copper vessel with small windows, it makes a very sensitive and rapidly adjusted instrument.

STANDARDISATION OF SIEVES.—In an article in the June issue of *State Technology*, Mr P. E. Masters directs attention to a difficulty under which British manufacturers who require to sift fine material labour, owing to the absence of any satisfactory standard to which sieve makers can work. A sieve of 80 meshes to the linear inch may be made of wire of gauge from 38 to 42 according to the will of the maker, and the user of the sieve only discovers a change of gauge by some serious modification of the properties of the sifted material. The proposals of the Institution of Mining and Metallurgy for standard sieves involve the use of wires not of standard gauges, and the sieves are so difficult to manufacture that high prices are quoted for them. The author proposes that the standard relation between the diameter d of the wire and the distance D of the centre lines of consecutive wires apart shall be $D = 2.7d$. This gives, as the proper wires for 10, 20, 30 and 40 meshes to the inch, gauges 19, 25, 29 and 33 respectively, for 60, 80, 100, 120, 140 and 160 meshes, gauges 37, 40, 42, 44, 45 and 46 respectively, and for 200 meshes, gauge 47 wire.

ERRATUM—In *NATURE* for July 11, p. 61, col 1, paragraph 2, line 13, the words "It is also a genus long known only from Europe" should refer to *Balanocrinus*.

The International Astronomical Union at Cambridge.

WELCOMED by Lord Balfour, Chancellor of the University of Cambridge, who dwelt on the value of international co-operation, by Dr. J. H. Jeans, president of the Royal Astronomical Society, who dwelt on the revolutions that astronomy has compelled in human thought, and by the Astronomer-Royal, who gave a short account of the manifold activities of the Union since its birth in 1919, the conference made a happy and successful start on July 14 in the Senate House of the University. In his address at the opening meeting of the general assembly of the Union, at which there were present more than 200 national delegates, members of the Union and invited visitors, the president, Prof. W. W. Campbell, reminded the Union that it is charged with the care of international co-operation in astronomy wherever it is necessary or useful. The principal fields of astronomical activity are represented by more than a score of committees; their reports refer to great pieces of work in which there are many students, where co-operation is required to secure a fairly homogeneous system over the entire field. He illustrated the point by a short historical account of the study of the variation in latitude. We have now a very good knowledge of the conditions that are requisite for success in astronomical co-operation, and in launching fresh schemes, as the Union must do from time to time, we must beware of starting on new and untried work with too ambitious a programme. Prof. Campbell added a strong and evidently welcome tribute to the work that the general secretary of the Union, Prof. A. Fowler, has done for it since its foundation.

Dr. G. Abetti, Dr. H. Chrétien, Lieut.-Col. F. Stratton, and Dr. F. Henroteau were appointed recorders for the meeting, and Dr. A. Wolfer was appointed vice-president for the meeting in the absence of Prof. K. Hirayama.

It was announced that Norway, Spain, Portugal and Switzerland are now full members of the Union, and the adherence of Sweden has been officially notified. There are now 22 countries in the Union, and 20 of these were actually represented at the conference. After considerable discussion, resolutions submitted by constituent bodies of the Union were submitted to committees, save one from the United States. This was a proposal that the Committee on Selected Areas should be invited to reorganise itself under the auspices of the Union. The motion was deferred until such time as Germany becomes an adhering country of the Union, a necessary condition which the American committee had hoped to see fulfilled at the Cambridge meeting.

The Union then dissolved itself into 27 committees, which for the next four days dealt faithfully each with its appropriate portion of the 122 pages of the report prepared by Prof. Fowler. It is impossible here to do more than mention very briefly some of the more important resolutions of wide interest which were ultimately adopted by the General Assembly of the Union.

The committee on standard notations appointed a sub-committee to report to the Union at a later date on a revision of the boundaries of the northern constellations. Different systems adopted by earlier writers have led to an annoying confusion in the double names allotted to stars near the boundaries of constellations.

It was agreed that for all telegrams transmitted from the Bureau at Copenhagen, mean places should be adopted, referred to the equinox at the beginning of the year. Where desired, adequate descriptions of newly discovered objects should be given.

A grant of 250*l.* a year for three years was made to Prof. De Sitter to carry out a programme of observations of azimuth at an equatorial station and at northern and southern stations, for the determination of fundamental declinations; the instrument and the observer are to be found by the Leyden Observatory. A revised list of stars to form, or to be developed into, a *fundamental* list was also adopted and recommended for as continuous observation as possible. The further study of the variations of refraction at different hours of the day and in different parts of the sky was also recommended. It was announced that Greenwich, the Cape and the Naval Observatory at Washington are to co-operate with the German astronomers in the observation of reference stars in connexion with the coming opposition of Eros in the year 1930-31.

With regard to solar physics, it was agreed to arrange that additional observations of the sun as nearly continuous as possible should be made at or about the time when magnetic storms are in progress or expected. There would have to be organised some service to supply the necessary information to the co-operating observatories. The view was expressed by M. Deslandres and adopted by the Union that it is important for the variation of the solar constant, announced by Dr. Abbot, to be studied in other countries, especially in reference to accompanying changes in meteorological elements. Strong support was given to the suggestion that a Solar Physics Observatory should be established in Japan. With regard to apparent changes in solar rotation, Dr. St. John announced that the Snow telescope as used by Adams would be reconstituted to compare its results with those given by the 150-foot tower telescope.

Several important resolutions were adopted as to standard wave-lengths. Of these the most important was the following:

The primary standard of wave-length, $\lambda 6438.4696$ of cadmium, shall be produced by high voltage electric current in a vacuum tube having internal electrodes. The lamp shall be maintained at a temperature not higher than 320° C., and shall have a volume not less than 25 cubic centimetres. The effective value of the exciting current shall not exceed 0.05 ampere. At room temperature the tube shall be non-luminous when connected to the usual high voltage circuit. So long as the lamp used is capable of giving well-defined interference fringes with retardations of at least 200,000 wave-lengths, it is not, however, necessary to specify the volume of the tube serving as lamp. The primary standard should always be produced in a lamp which is ascertained to give retardations of at least 200,000 wave-lengths.

General Ferrié announced that the world scheme for the wireless determination of longitudes as approved at Rome has been worked out in further detail; experiments of considerable interest with diverse optical instruments have been carried out at Paris to check the conflicting views as to the relative success of small field instruments and large observatory transit circles. A number of resolutions as to the details of the scheme were adopted. Some preliminary experiments are to be carried out during the two months commencing October 1, 1926.

A strong wish was expressed by the Union that the U.S. Coast and Geodetic Survey should re-establish the latitude station at Gaithersburg so as to renew its co-operation in the study of the variation of latitude. The help of meridian observers in securing fresh

determinations of the declinations of the stars involved in this work was also strongly urged.

A research survey for all the minor planets, giving a record of available fundamental investigations on the perturbations of minor planets, was approved by the Union on the suggestion of Prof. Leuschner.

Observatories with suitable instruments were asked to arrange to secure annually photographs of the meteors of the three annual showers, the Perseids, Orionids and Geminids.

Welcome news was given by Prof. Turner as to the progress of the *Carte du Ciel*. France and Italy hope to complete their zones in eight years' time or sooner. The chief delays are at Tacubaya and Sydney, and the Union appealed to the two governments concerned for more rapid prosecution of the work.

In parallax work it was recommended that observers of trigonometric parallaxes should shape their programme, so far as possible, to meet the needs for spectroscopic and dynamical determinations. Faint stars of large proper motion are especially important. It was also agreed that photometric observers should be urged to determine carefully the magnitudes and colour equivalents of these stars.

Prof. von Zeipel reported through the Committee on Photometry that at Upsala it is proposed to determine the photographic and photovisual magnitudes of the 11,700 stars in the A.G. catalogue between $+35^\circ$ and $+40^\circ$.

A grant of 6000 francs was made to Dr. Aitken at the Lick Observatory for the clerical work of the Double Star Bureau, in connexion with the extension of Burnham's General Catalogue. The use of the reversing prism in determining position angle in double stars was also approved.

During the meeting co-operative work on the important Cepheid variables was arranged. As to notation, the Union supported that of Chambers—André—Nijland. A list of variable stars needing special attention, drawn up by Prof. Nijland, was published in the report of the Committee on Variable Stars.

It was agreed that a new catalogue of the brighter and larger nebulae should be drawn up, illustrated by plates and including globular clusters. The system to be adopted for classification is to be purely descriptive. It was also recommended that in published work on nebulae the N.G.C. or I.C. number should always be used, and that steps be taken to divide the sky into zones allotted to different observatories for work on agreed lines on nebulae. It was also agreed that observatories should be encouraged to publish, whenever possible, copies of their best spectrograms.

This would be of assistance for the next stage in stellar spectral classification. A small catalogue of some 20 to 25 stars is to be prepared to serve as standards in radial velocity work.

Important resolutions were adopted amending the forms, times and modes of emission of radio time signals. For the international time system at certain times it was agreed to replace the present three dashes by six dots.

The above brief summary of the more interesting resolutions indicates that a large volume of work was got through in the various committees. In addition, much valuable material is incorporated in many of the reports of the committees, especially in the accounts of recent work. It is to be hoped that the volume of proceedings may shortly be available to the public. The reports of the committees were for the most part taken without discussion at the general assembly in its closing meetings, the one fight being over the question of the hour of commencement of the Julian day. By a large majority it was agreed that this should remain at noon. The failure of the International Research Council at its recent meeting at Brussels to make any change in the statutes governing the conditions of national adherence led to a number of statements being made by the various national delegations. The United States, Italy, Japan, Spain, Denmark, Sweden, and Canada urged that all restrictions should be removed, while Belgium, France, Poland, Czecho-Slovakia, Portugal, and Rumania contented themselves with asking the International Research Council not to block the admission of the Central Powers when they became members of the League of Nations.

The next meeting of the Union was arranged, on the invitation of the Dutch government, to take place in Holland in 1928. The committees of the Union were appointed for the next three years, including new committees on stellar statistics and on solar parallax. Officers of the Union for the next three years were elected as follows:—Prof. De Sitter (president); Profs. Cerulli, Deslandres, Hirayama, Eddington, and Schlesinger (vice-presidents); Lieut.-Col. Stratton (general secretary).

A very successful meeting closed on July 22. Generous hospitality was shown throughout by the Colleges. Amongst many interesting points referred to in the side meetings was an announcement that Prof. Adams has measured the Einstein shift in the spectrum of the companion to Sirius. The result is consistent with the theoretical view already announced, that this star, though 2000 times as dense as platinum, obeys the gas laws.

The Field Museum of Natural History, Chicago.

THOSE connected with museums in Great Britain generally read the annual reports of museums in the United States with some envy. This is partly because those reports are produced in a style to interest the reader and to do credit to their institutions, partly because of the vigorous work they reveal. The chief factors, no doubt, are brains and enthusiasm, but these cannot operate without the other factor—sufficient funds. The report of the Field Museum of Natural History, Chicago, for 1924, which is just to hand, illustrates these points. It consists of 115 pages, of which half give a readable account of progress, and it is illustrated by 16 photogravure plates prepared in the Museum, as are all the Museum publications. That is how it is possible for the volume to bear the date January 1925.

The Field Museum corresponds to our own Natural

History Museum plus a department of anthropology. Its scientific staff, exclusive of the Director, numbers only twenty, but its expenditure last year was about 117,370*l*. The expenditure of our Natural History Museum for last year was about 97,925*l*, and the scientific staff numbers forty-three permanent and thirteen temporary members.

The extension work of the Field Museum in public schools, the reproduction of living plants in models, and the pensions to employees are provided for by separate funds. Setting those activities aside, one notes that about 5000*l*. was spent during the year on expeditions; then there are three guide-lecturers, who, besides conducting visitors, give regular lectures illustrated by lantern and cinematograph, the printing has already been mentioned, but it should be added that this includes a large number of coloured posters

and advertisement folders. Such are a few of the lines of work in which British museums of similar size and character cannot compete. This expenditure, however, cannot be regarded as wholly unproductive, for it must certainly attract a large number of subscribing members. In Great Britain most museums are maintained by compulsory imposts, and free gifts of money are harder to come by. Whatever may be the relative advantages or disadvantages, it is certainly creditable to the citizens of the United States that they support so many admirable museums by private generosity.

From the body of the report a few items may be selected as continuing the contrast. Leakage through the roof of the top-lighted halls has been remedied in drastic fashion by coating the 38,500 square feet of skylights with a double thickness of Celotex overlaid with Ruberoid roofing. This has involved a change in the lighting of the halls from daylight to electric light. Making a virtue of necessity, it is claimed that artificial lighting is more suitable for the exhibited material because the illumination is more uniform and avoids the fading effects of sunlight. Since many American museums have long surpassed those in Britain in the use of electric light, we may be sure that some of the "dazzle headlight" effect recently introduced into one of our largest metropolitan museums has been avoided; but we are not so sure about the fading.

A somewhat full account is given of the re-erection of two Mastaba tombs from Egypt. The blocks arrived in 206 cases weighing 96 tons. The lower courses and missing stones have been replaced by cement blocks. The stones are bedded in lead, joined by dowels and metal clamps, and each secured to a bracketed upright steel channel. The ceiling has been raised 18 in. above the walls, and hidden lights are in a trough on the top of the wall. Every

care has been taken to prevent humidity, and the room at the back of the tombs is mechanically ventilated. These and other details are given in the report "in the hope that the information may prove useful to other institutions." The use of terms unfamiliar, at least in Great Britain, and the absence of illustrations will, it is to be feared, frustrate this hope.

A poisoning and storage room, apparently in five sections, for the preservation of perishable material, has been constructed of compressed steel and equipped with storage bins of cedar wood. Formaldehyde candles have been used for poisoning with good success.

Many British provincial museums have long experienced the popularity of a wild flower exhibit, but none of them has attempted to show living and growing wild plants on anything like the scale attempted last year in the Field Museum. The case was a kind of large flower-box, and soon proved so successful that it was replaced by one four times the size, permitting of an approximately ecological grouping, which ranged from sand-dune plants to water plants. During the season about 500 species were shown, with full labels and guide leaflets.

Though not of such interest to the public, the numerous paragraphs revealing what careful attention is paid to storage, unpacking, sorting, and general office equipment will be read with appreciation by all museum curators. Nothing is more difficult to impress upon governors, committees, architects, and providers of funds than the fact that the life of a museum is in its workrooms and workshops, and that in any plans for development the first attention should always be paid to those unseen but indispensable offices. What is a banquet hall without its kitchen? We can better dispense with the toast-master than with the cook.

F. A. BATHER.

The Sixth International Conference of Pure and Applied Chemistry.

SOME seventy foreign delegates, representing twenty different countries, attended the conference which was held recently in Bucharest. The decoration of railway stations and of public buildings and the more than generous hospitality provided by private individuals, public officials and organisations throughout the duration of the conference, indicated how important the event was considered in Roumania, and demonstrated the sympathetic attitude of its people towards chemistry.

The actual business of the conference was transacted on June 22-June 25 under the presidency of Sir William Pope, and the other British delegates were Prof. J. C. Drummond and Prof. C. S. Gibson. The prestige of British chemistry can scarcely be said to have been adequately maintained since Denmark, the United States, Spain, France and Italy were each represented by a larger number of delegates than Great Britain. At the opening official reception, H. R. H. the Crown Prince of Roumania was present and, later, representative delegates were entertained by their Majesties the King and Queen at the Royal Palace at Sinaia.

Apart from the work of the special committees which met in the mornings and afternoons, a discussion on "The Nitrogen Problem," in which Prof. F. Giordani of Naples and Prof. D. Staehelin of Bucharest took part, was of special interest in connexion with the natural resources of Roumania. Public lectures were also delivered by Prof. Charles Moureu and Prof. Ernest Fourneau on "Autoxidation and Catalytic Phenomena" and "The Relationships between the Chemical Constitution of Substances and their Physiological Properties" respectively.

At the closing meeting, Prof. Ernst Cohen of Utrecht was unanimously elected president of the Conference in succession to Sir William Pope, who, like his predecessor, Prof. Moureu, has held this important office during three years. Mr. Jean Gérard was re-elected secretary and the following were appointed vice-presidents for the ensuing year: Profs. Bertrand (France), Minovici (Roumania), Nasini (Italy), Norris (America), Pictet (Switzerland) and Swarts (Belgium). The invitation from the United States to hold the next conference in Washington in September 1926, on the occasion of the fiftieth anniversary of the American Chemical Society, was cordially accepted.

An unique opportunity of seeing something of the enormous natural resources of Roumania was afforded to the delegates by the visits to the factories at Mediás and Dicioşanmartin, where natural methane is used not only as a source of heat and power, but also for the production of cyanamide. At the present time, the economic development is in its infancy, and there are still great possibilities for the scientific exploitation of methane of 99 per cent. purity issuing from the earth at a pressure of 20 to 30 atmospheres. The oil refinery of the Steaua Romana Company and the famous salt mines at Slanic were also inspected, and at all these places the same kindness and hospitality were freely extended to the delegates.

The Bucharest conference was a model of efficient organisation, and Prof. Minovici and his committee have earned the sincere thanks of those privileged to attend and to join in the excursion to Constantinople, which was a *grand finale* to a most wonderful experience.

C. S. GIBSON.

Wheat Supply and Demand.¹

THE three issues of "Wheat Studies" noticed here form the preliminary instalments of a monthly series which the notice states is "designed to give a sound, impartial review of the world wheat position and outlook, based upon careful analysis of the various elements in the situation, with due recognition of economic conditions in exporting and importing countries." Numbers 1 and 3 form a continuous record of the vagaries of the wheat market over a period of seventeen months, when the market situation changed from that of being a buyers' to that of a sellers' market, thus allowing of contrasting conditions being compared equitably under almost uniform conditions of exchange and dietary habits.

No. 2 is a bibliography of the sources of the data upon which the main thesis is based.

The cause of low prices in 1923-24, the rise toward the end of the year, the reasons for export by Soviet Russia though crops were insufficient for home needs, and the cause of a marked increase in Oriental demand are all passed under review, and in a quite untechnical manner are explained.

Many interesting and important facts are deduced from the mass of statistics handled by the authors. Dietary changes due to better conditions among the artisan class since the War are having a significant influence upon the *per capita* consumption of wheat. In Great Britain the direction is downward, more meat being eaten, but in Scandinavia the same underlying cause promotes an upward movement owing to the falling off in rye consumption.

Figures are quoted showing that imports are not governed so much by the state of the home crop as by the state of the market. Abundant crops at home and abroad in 1923-24 were accompanied by a large increase in imports into Great Britain. Japan and China were attracted by low prices and consumed a quantity of wheat which is not likely to be a standard demand under the conditions which developed at the end of 1924. One of the most interesting sections of the survey is that explaining the effect of crop prospects changes, political disturbances of the nature of presidential elections, and geographic considerations such as the closing of navigation on the Great Lakes, on the course of wheat prices at Liverpool, Winnipeg, Chicago and Buenos Aires. A remarkably close correlation can be traced in almost all cases.

The series is the result of team-work, and very little time elapses between the data becoming available and the publication of the analysis. Under such conditions the readableness and accuracy of "Wheat Studies" are all the more praiseworthy.

¹ "Wheat Studies of the Food Research Institute, vol. 1. (Stanford University, California). No. 1, The World Wheat Situation, 1923-24, a Review of the Crop Year, No. 2, Current Sources concerning Wheat Supplies, Movements and Prices: a Select List with Comments, No. 3, Developments in the Wheat Situation, August to December 1924.

Symbiotic Micro-organisms.

IN an article in *Scientia* (April 1925) Prof. U. Pierantoni, of Turin, who has taken a leading part in the investigations on physiological symbiosis, points out that recent researches in this domain have revealed the existence of micro-organisms which are not only useful but also, in the majority of cases, necessary for the life of the superior organism in which they occur, and they are transmitted from parent to offspring. These researches have also made known a new category of organs—termed mycetomes—which owe their functions to the presence in the

protoplasm of their cells of symbiotic organisms, so that these by their specific activity determine the action of the organ. These symbiotic organs are glands, the protoplasm of the cells of which, instead of elaborating products of secretion, foster micro-organisms which produce secretions useful to the organism.

The author states that the useful species of micro-organisms outnumber the pathogenic species. Among the examples of symbiotic organs to which Prof. Pierantoni refers are the luminous organs of cephalopods (*Heteroteuthis*, *Rondeletia*, *Sepiola*) which he has investigated, and the luminous organs of certain fishes (*Anomalops*, *Protoblepharon*) investigated by Prof. E. N. Harvey. He points out that these organs are simply cutaneous invaginations which harbour the micro-organisms, and that the thin walls in contact with rich vascular networks protect the cultures while the blood provides the nutrient material required by the micro-organisms. The latter multiply and produce continually new luminous substances which replace those expelled from the organ to the exterior by muscular action under nervous stimulation. In some cases, reflectors and refractors are formed from the neighbouring tissues; these render the light emitted more brilliant.

Another important group of symbiotic organs is the mycetomes in the wall of the intestine and associated organs—e.g. in larval and adult insects which feed on wood and blood, and in ticks—which elaborate ferments that facilitate the digestion of wood, cellulose, chitin, etc. A third group of these symbionts is chromogenic. The author observed in 1912 that in certain homopterous insects the symbiotic organ exhibited a bright colour which he attributed to the contained micro-organisms. Other investigators have recently found that the red lac of India produced by the coccid *Tachardia lacca* results from the activity of a micro-organism, allied to the *Blastomycetes*, which has been isolated and cultivated. The absorption spectrum of red lac exhibits an affinity with that of carminic acid (from cochineal, also the product of a coccid) and of the red products of the chromogenic *Bacillus prodigiosus*. Prof. Pierantoni believes that we are only at the beginning of a line of inquiry likely to be rich in results in pure and in applied science.

University and Educational Intelligence.

BIRMINGHAM.—Applications are invited for the Walter Myers Travelling Studentship in Pathology, value 300*l*. Information concerning the studentship can be obtained from the Dean of the Medical Faculty of the University. The latest date for the receipt of applications is September 1.

BRISTOL.—In connexion with the recent meeting of the British Medical Association at Bath, the honorary degree of LL.D has been conferred on Sir Humphry Rolleston, Bart, Regius professor of physic in the University of Cambridge and president of the Royal College of Physicians.

DURHAM.—At a meeting held on July 27 the Council of Armstrong College, Newcastle-upon-Tyne, appointed Prof. J. W. Bews, of Natal University College, Pietermaritzburg, to be professor of botany in succession to Prof. M. C. Potter, retired. Dr. Bews is a native of the Orkney Islands, and was educated at Kirkwall and at the University of Edinburgh. He has been a lecturer in botany at the Universities of Manchester and Edinburgh, and since 1910 has been professor of botany at Pietermaritzburg. His publications include "Grasses and Grasslands of South Africa" (1918), "Flora of Natal and Zululand"

(1921), "Plant Forms and their Evolution in South Africa" (1925), and numerous papers dealing with plant distribution in South Africa

EDINBURGH—At the Graduation Ceremonial on July 22 the following were among the honorary degrees conferred:—LL.D.: Brig-General the Hon. C. G. Bruce, chief of the Mount Everest Expedition, Prof. A. S. Eddington, Plumian professor of astronomy and natural philosophy in the University of Cambridge, Prof. R. Muir, professor of pathology, University of Glasgow, Principal C. Grant Robertson, University of Birmingham; Sir H. J. Stiles, Regius professor-emeritus of clinical surgery in the University of Edinburgh.

The degree of D.Sc. was conferred on the following.—Mr. A. C. Aitken (Thesis—"The Graduation of Observational Data"); Dr. F. J. Browne (Thesis—"Observations on Still-Birth and Neonatal Death, their Causes, Pathology and Prevention"), Mr. A. T. Cameron (Thesis—"Contributions to the Bio-Chemistry of Iodine and the Thyroid and Related Problems"); Mr. G. Harrower (Thesis—"A Study of the Hoken and Tamil Skull"); Mr. J. B. Shoosmith (Thesis—"The Influence of the Nature and Position of Atoms in Organic Compounds on the Reactivity of other Atoms in the Molecule").

LONDON—Mr. J. S. Huxley, fellow of New College, Oxford, and senior demonstrator in the Department of Comparative Anatomy, has been appointed to the University chair of zoology tenable at King's College. Prof. Huxley was educated at Balliol College, Oxford, where he was Brakenbury Scholar, and also studied at the Stazione Zoologica, Naples, and at Munich and Heidelberg. From 1913 until 1919 he was assistant professor of biology in the Rice Institute, Texas, where he entirely organised the Department of Biology. He helped to organise and took part in the first Oxford Expedition to Spitzbergen in 1921, and in 1924 he visited numerous universities in Canada and the United States. His publications include: "The Individual in the Animal Kingdom" (1911), "Essays of a Biologist" (1924), and numerous papers in the *Philosophical Transactions* and *Proceedings of the Royal Society*, the *Quarterly Journal of Microscopical Science*, and in other scientific journals, he is also assistant editor of the *British Journal of Experimental Biology*.

Dr. L. Rodwell Jones, Cassell lecturer in commerce in the London School of Economics, has been appointed to the University chair of geography tenable at the School.

Mr. E. C. Titchmarsh, senior lecturer in mathematics at University College, has been appointed to the University readership in mathematical analysis tenable at the College. Mr. Titchmarsh had a distinguished career in mathematics at Balliol College, Oxford, and is the author of numerous papers in the *Proceedings of the Royal Society*, *London Mathematical Society*, and the *Cambridge Philosophical Society*.

The title of reader in medical protozoology in the University has been conferred on Mr. J. G. Thomson, lecturer in protozoology at the London School of Tropical Medicine since 1914, in respect of the post held by him at the London School of Hygiene and Tropical Medicine. He has held the following posts.—Durning Lawrence Research Fellow, 1909, and Clinical and Pathological Research Fellow, 1913, Liverpool School of Tropical Medicine; Beit Memorial Fellowship, 1914; Protozoologist, Central Laboratory, Alexandria, 1915; Pathologist, 17th General Hospital.

The Degree of D.Sc. in botany has been conferred on Mr. Krishnadas Bagchee (Imperial College—Royal College of Science), for a thesis entitled "Cytology

of the Ascomycetes. *Pustularia bolarioides* Ramst. I. Spore Development"

THE Association of University Teachers announces in the June number of the *University Bulletin* the constitution of a Joint Standing Committee and inquiry office for promoting co-operation between university libraries. The inquiry officer is Mr. L. T. Oldaker, The Library, University, Edmund Street, Birmingham. Another interesting announcement which appears in the *Bulletin* is that the Council of University College, Reading, has decided, following the example set by Birmingham and already followed by Armstrong College, to form a standing Research Board to take responsibility for the promotion of research and the allocation of available funds. Evidence of the strength of the movement for promoting associations of university *alumni* and *alumnæ* is afforded by the announcement that the membership of the Leeds University Old Students' Association has increased since February 1924 from 500 to 1000.

THE Air Ministry announces that seven hundred aircraft apprentices, between the ages of fifteen and sixteen and a half years, are required by the Royal Air Force for entry to the Aircraft Apprentice School at Halton, Bucks, in January next. These apprentices, who must be well educated and physically fit, will be engaged as the result of two examinations, one an open competition conducted by the Civil Service Commissioners, and the other a limited competition carried out by the Air Ministry in conjunction with the local education authorities throughout the country. Since the aircraft apprentice scheme was inaugurated in 1920 approximately 2000 boys have completed their training and are now at work in service squadrons both at home and abroad, while approximately 3000 boys are now regularly undergoing training. Application to sit in the open competition must be made to the Secretary, Civil Service Commission, Burlington Gardens, W. 1, not later than September 3. Candidates for the limited examination should make application, if they are still at school, to their headmasters with the view of securing a nomination from the education authority responsible for the school. If they have left school, application should be made to the Advisory Committee for Juvenile Employment in their area. Applications must be received by the Air Ministry from nominating bodies by October 6. The syllabus for both examinations consists of mathematics, experimental science, English and a general paper. Copies of the regulations for entry (A.P. 134) can be obtained on application to the Secretary (M. 1), Air Ministry, Kingsway, W.C.2.

EDUCATIONAL research in America is greatly helped and stimulated by the publication by the Bureau of Education at short intervals of up-to-date bibliographies. We have just received a 30-page pamphlet giving some 500 references on higher education. There are no less than twenty references on the application of intelligence tests to candidates for admission to college and to undergraduates. In Columbia College intelligence tests have been used continuously since 1919 and have been found very useful. The Thorndike test of intelligence for high-school graduates has been found the best single criterion for admission to the college, and the Thorndike special intelligence test, used in the Columbia Law School, predicts success in the school better than the average college grade does. These and other similar data were published in an article by the assistant professor of educational research in Columbia University contributed to the March issue of *School Life*.

Early Science at Oxford.

August 5, 1684. A Discourse of Sir William Petty's, concerning Land Carriages, was read.

A Discourse concerning Digestion, and ye ferment of ye stomach, drawn up by Mr. Lee of Brazenose College, was read, and will be printed in a little time.

Some Seawater sweet'ned lately by Dr. Plot, Mr. Lee, and Mr. Musgrave, was shewn ye Society, and judged to be not in ye least salt to ye tast, and fit for use.

Dr. Plot presented ye Society with some of ye *Pindus*, from ye Coast of Guinea; of which substance ye inhabitants make their bread, and severall meats; it seems to be a round seed: He also communicated some sawdust of a wood from Jamaica (ye name of which as yet wee know not) which being put into cold water, did in some few minutes, tinge the water of a delicate mulberry color.

Dr. Gibbons gave ye Society an account of a well near Cambden, ye water of which (as he is informed) tinges with galls, a day, or two, after it is taken from ye spring, then intermits for eight or ten days, and after that tinges again: he promises a more full account of this matter. An Account of ye weather ye last month, taken (as usually) according to Dr. Lister's scheme, was brought in by Dr. Plot.

The Society was informed, that Mr. Lee of Brasenose College has lately received a letter from a friend of his in Lanchashire, who lived severall years at Tangier, and assures him, that, during ye time of his stay there, he enquired into ye nature of ye current at ye Streights Mouth, by letting fall lines with weights at ye end of them, and that, which way soever ye upper Current went, ye lines were driven outwards; of which he sent this account to Mr. Lee, takeing ye occasion from what he finds printed by Dr. Smith in ye Transactions concerning this Subject; This matter will be farther enquired into, and (if possible) a relation of it be had under ye gentleman's hand.

August 12, 1684. Ye Minutes of ye Dublin Society, from June ye 9th, to July ye 21st, 1684, being read distinctly, and considered, it was ordered that Mr. Ash, and Mr. Molineux be desired to impart their observations on ye last solar eclipse, to be printed with those made at Greenwich, and Oxon.

It is also desired, that Mr. K— would be pleased to communicate an account of his Mesolabe. Ordered that Dr. Pitt be desired at his leisure to draw up, and communicate to this Society, his thoughts concerning Digestion.

Sr Wm. Petty's paper of Land carriages, read ye last Meeting, enquiring into ye reason of ye Dishing of cart-wheels, Mr. Walker was pleased to communicate these lines concerning it. (One reason of ye Dishing of Cart-wheels seems to be this; when one wheel falls into a Hole, or deep cartrut, so that most of ye weight lyes upon it, then ye lower part of that wheel stands more perpendicularly to ye plain of ye Horizon, and consequently bears ye weight better than if ye wheel were plain, and not dish't.)

A letter from Dr. Turberville of Salisbury was read, it gave an account of ye three following cases.

1 The *Bursa Oculi*, which was in ye white of ye eye, under ye upper lid, an empty purse, no matter in it, and hung flagg about ye length of a thumb nail.

2 Another had no visible disease in his eyes, but could not see at all without squeezing his nose with his fingers, or saddling it with narrow spectacles, and then he saw very well: him ye Doctor carried to Mr. Boyl. 3 Another from Banbury, a Maid of 22 or 23 years old, could see very well, but no color, besides black and white. She saw Scintillations by night, that much terrified her.

Societies and Academies.

LONDON.

Royal Anthropological Institute, June 9—Shams-ul-ulama Dr. Jivanji Jamshedji Modi: The daily life of a Parsee of the seventeenth century, as described in the Persian Farziât-nâme of Dastur Darab Pâhlan. The daily religious duties began with early rising at the crowing of the cock (a sacred bird, not to be killed for food, and even requiring a kind of sacred burial), followed by a recital on, or very near, the bed, of Ashem Vohu, a sacred formula of prayer in praise of Asha (Sanskrit *rita*; English, right). This was followed by the application, on the exposed portions of the body, of *mrang* or *gaomiz*, i.e. the urine of a cow (*gao*), held by the ancient Aryans as a purifying substance. The application was followed by an ordinary ablution or, in special cases, by a bath. This was followed by a prayer, and there were five periods during the day for such obligatory prayers. The ablution or bath was accompanied by the untying and re-tying of the *kusti*, or sacred thread, which a Parsee had always to put on, on a sacred shirt, as symbols of his religion. The ablutions with the requisite ritual were required after calls of nature and before meals, which began with the recital of grace. A morsel was set apart for the dogs of the house or street, semi-sacred animals useful for various purposes. For his daily diet meat may be used as little as possible, and, for that purpose, not healthy but weak animals were to be killed. It was his duty to kill noxious creatures such as serpents, scorpions, mice, and the like. All kinds of scepticism in religious matters were to be avoided. A serious and solemn view of all daily actions had to be taken, and recitals of prayers for the blessing of God upon them were required. The day ended with a recital of prayers.

Linnean Society, June 11.—W. Bateson: Pelargoniums and the production of bud-sports. Sports are probably due to the emergence of a distinct, previously existing component, originally formed by somatic segregation at an early stage. Not very rarely the hidden component, perhaps most often a dominant, forms the central core of a periclinal system, emerging regularly in buds formed adventitiously on roots of inverted plants. Not improbably the whole root belongs to the inner component. Mosaic chimæras with islands showing a dominant also occur. A growing point arising in such an island forms a periclinal with the dominant external. The core on emergence is frequently still mosaic.—F. Eyles: Remarks on the flora of Southern Rhodesia. The type occupying a larger area than any other is the open forest, with trees widely spaced, not often exceeding 50 ft. in height, with a sparse undergrowth. From the ecological point of view, water is the chief controlling factor: the edaphic influence is also considerable; while temperature has less effect on distribution, owing to the relatively small degree of local and seasonal variation. Rain-fall occurs in two clearly defined seasons, namely, six months of wet season and six months of dry season; therefore all perennials must be adapted to face and survive six months of drought every year. This necessity is met in the usual way.—W. Garstang: On the origin of the crustacean carapace. The cephalic shield is regarded as having arisen as a larval organ, in response to larval needs. It is assumed that the proximate ancestors of Crustacea, prior to the development of a cephalic shield, were essentially trilobites of lower Cambrian type, and that the larvæ were discoidal and fitted only for

flotation. Thus the so-called "typical" nauplii of Copepoda, etc., with powerful rowing antennæ, are less primitive than the discoidal small-limbed nauplii of Limnetis and Cirripedia. On the development of post-cephalic segments, the trunk-rudiment sinks below the plane of the head, and the head repairs the breach in its suspensory disk by an outgrowth from behind. This is claimed to have been the origin of the carapace—a larval adaptation to lengthen the pelagic phase. Finally, on the larvæ sinking to the bottom, the carapace, as a result of its successive adaptations to pelagic conditions, was a structure big enough to be made use of for a variety of modes of adult life.

Mineralogical Society, June 16.—A. Hutchinson: (1) The use of the stereographic protractor for the interpretation of Laue crystal photographs. By a slight modification, the stereographic protractor previously designed by the author can be used for the interpretation of Laue photographs. (2) The use of alignment charts in crystal optics. The alignment charts in common use amongst engineers can be applied to the calculation of refractive indices measured on the total refractometer.—H. E. Buckley and W. S. Vernon: The crystal-structures of the sulphides of mercury. The powder method of X-ray analysis showed that the precipitated black sulphide is cubic, with the symmetry of the natural metacinnabarite and with an arrangement of atoms like that of zinc blende, $a = 5.85 \text{ \AA.U.}$, $d(\text{Hg-S}) = 2.54 \text{ \AA.U.}$ In cinnabar the arrangement of the mercury and sulphur atoms is a rocksalt one, slightly compressed along the trigonal axis and with a slight readjustment of atoms parallel to the basal plane, $a = 4.16 \text{ \AA.U.}$, $c = 9.54 \text{ \AA.U.}$, $c/a = 2.291$. The type of movement in best agreement with the symmetry is D_3^4 . In cubic mercuric sulphide each atom has four oppositely charged neighbours at a distance of $2.54 \text{ \AA.U.}$, while in cinnabar two neighbouring atoms are situated at a distance of $2.54 \text{ \AA.U.}$, as in the cubic mercuric sulphide, and two others at a distance of $2.91 \text{ \AA.U.}$ These facts indicate an eccentricity of the mercury atom if the sulphur atoms are regarded as spherical. In cinnabar, in accordance with the circular polarisation, sulphur atoms run down through the structure in trigonal spirals.—Edmondson Spencer: Albite and other authigenic minerals in limestone from Bengal. The limestones of Cuddapah age near Raipura, Bengal, contain well-formed crystals of pure albite, apparently authigenic in origin. The crystals are tabular on the brachy-pinakoid and are lozenge-shaped. They are twinned on Carlsbad and albite laws similarly to those of the well-known Roc-tourné type, but of different habit. Accompanying the albite are phlogopite, tourmaline, and quartz crystals, all believed to be authigenic. Comparisons are instituted with similar occurrences of feldspars in limestones from various European localities.—Robert Campbell and J. W. Lunn: Chlorophæitite in the dolerites (tholeiites) of Dalmahoy and Kaimes Hills, Edinburgh. The dolerites of Dalmahoy and Kaimes Hills are exceptionally rich (up to 15 per cent. or more) in chlorophæitite, which occurs as a vesicle mineral, as veins, and as pseudomorphs after fayalite. The mineral has a refractive index 1.498, hardness 1.5, and density 1.81; it has no cleavage and is isotropic. It shows on exposure a striking colour change from bright olive-green to black, due to rapid oxidation. From its physical and chemical characters the mineral is regarded as of a colloidal nature.—L. J. Spencer: Tenth list of new mineral names; with an index of authors.

Royal Meteorological Society, June 17.—J. E. Clark, I. D. Margary and R. Marshall: Report on the

phenological observations in the British Isles from December 1923 to November 1924. In this thirty-fourth report, 365 sets of records are discussed, compared with about 120 before 1922; the N.W. half of Ireland and most of West and North Scotland are still practically bare. The year was described officially as "Dull and very wet with a very cloudy summer." Again it began mild, the four weeks to February 10 averaging 6° warmer than the succeeding four. Sudden heat-bursts again raised false hopes, and made the records of plants, insects and birds again erratic. Almost everything was much later than in 1923, and on the 30 years' average, flowers in the E. and S.E. were one to two weeks late; N. England and Scotland still more. Yet the hazel was early; blackthorn, eleven days behind in S. Britain, latest of all. Insects, appearing later, ranged from 18 days late for the honey bee to three only for the Orange Tip, with the Meadow Brown in June a week early; so too the migrants. Vegetable growth was exceptional, and little troubled by insect plagues, though slugs, snails and fungoid troubles were bad. Tree fruit was scarce and of poor quality. Grain and hay were saved with difficulty; potatoes were often diseased, but green crops and roots were some compensation.—D. N. Harrison and G. M. B. Dobson: Measurements of the amount of ozone in the upper atmosphere. Following the general method of Fahy and Buisson, the amount of ozone present in the atmosphere has been measured by spectroscopic means. A marked connexion is found between the amount of ozone and the general pressure distribution at the surface, and a still closer connexion with the conditions at about 10 km.—J. Baxendell: Meteorological periodicities of the order of a few years, and their local investigation; with special reference to the term of 5.1 years in Britain. The following meteorological periodicities seem to be established: 5.1, 3.1, 2.8, 2.4, 2.2, and 1.63 years. Working on foreign and feeble English cycles, several of the shorter terms appear to be exact half-harmonics of certain of the longer ones; while there are also third-harmonic components. The 5.1-year term was found at Southport in the 'eighties, and has since been independently detected by five investigators elsewhere, two of whom have traced it back for three centuries. It is especially pronounced in the frequency of the colder wind-directions, in Lancashire and at Greenwich; but values for the term in rainfall, temperature, air pressure, severe winters, and other data, are also given.

Geological Society, June 24.—W. J. Sollas: On a sagittal section of the skull of *Australopithecus africanus*. Sagittal sections of the skulls of the anthropoid apes, the Hominidæ, and the Taung's skull, show that the last-named presents numerous and important characters, by which it differs from the anthropoids and makes some approach towards the Hominidæ. The claims of *Australopithecus* to generic distinction are justified.—D. Parkinson: The faunal succession in the Carboniferous Limestone and Bowland Shales at Clitheroe and Pendle Hill. The rocks form that portion of the south-eastern limb of the Clitheroe anticline which is included between the Twiston and Clitheroe faults, along with most of the scarp-face of Pendle Hill. The lowest beds appear to be of Z age, but the junction of Z and C is an uncertain horizon. The knoll-limestones pass laterally into shales and crinoidal limestones. The Worston Shale series is overlain by the *hodderense* goniatite-band, which forms a constant feature along the foot of Pendle Hill. The Pseudobilingue zone terminates below the Pendle Grit, where another goniatite (possibly *H. leyon*) appears, and forms a continuous horizon just below the grit. It is suggested that the

base of the Upper Carboniferous should be drawn here. The Worstons shales appear to have been deposited on a very uneven sea-floor, the irregularities being due to the mode of accumulation of the limestones, and not to interformational uplift and erosion.—Miss J. M. M. Dingwall: *Cyathoclisia*: a new genus of Carboniferous corals. Certain Tournaisian corals of limited range, which are fairly abundant in certain localities in the south-west of England and South Wales, are described. These forms agree with *Clisiophyllum* in their general features, but differ so markedly from the Viséan species of the genus in structural details that it has been assigned the new generic name, *Cyathoclisia*, suggested by Dr. W. D. Lang. The members of this genus are simple rugose corals. One species, *C. tabernaculum*, shows remarkable variability; it appears to have a limited distribution, both horizontally and vertically. So far as is known, it is confined to the south-western province of the Carboniferous Limestone. *Cyathoclisia* may have been developed from *Palæosmilia*.

PARIS.

Academy of Sciences, June 29.—A. Lacroix: The meteorites of Tuan Tuc (June 30, 1921) and of Phu Hong (September 22, 1887) in Cochin China. In the Tuan Tuc fall there were two meteorites found at a distance of 40 kilometres apart. These were similar, being olivine and hypersthene chondrites. The Phu Hong meteorite was a chondrite containing olivine and bronzite.—H. Deslandres: Complementary researches on the structure and distribution of band spectra.—G. Bigourdan: The topographical influences which affect the pendulum corrections employed at the B.I.H.—A. Haller and R. Cornubert: The constitution of dimethylcyclopentanone and of dimethylcyclohexanone in which alkyl groups have been introduced by the sodium amide method.—Gabriel Bertrand and M. Machebeuf: The proportions of cobalt contained in the organs of animals. Cobalt is found along with nickel in the organs of man and animals. Numerous data are given, together with the methods adopted for the determinations. The mode of distribution of the cobalt in the various organs is approximately parallel to that of nickel.—Charles Richet, Eudoxie Bachrach, and Henry Cardot: The hereditary fixation of acquired characters, proved by the stability of the displaced thermal optimum. After cultivating the lactic ferment over a long period in a medium containing a large proportion of potassium chloride, a lactic bacillus is obtained possessing two new characters; resistance to potassium chloride is increased and the thermal optimum is strongly displaced in the direction of a higher temperature. These acquired characters have proved to be stable.—Rollet de l'Isle: The method of elaboration and of publication of international scientific and technical vocabularies.—R. H. Gernay: The periodic integrals infinitely near partial differential equations of the first order.—Armand Cahen: The continued fractions attached to operations about one unit above or below.—Léon Pomey: The determination of the integrals of differential equations by general initial conditions.—J. L. Walsh: The position of the roots of integral functions of genus one and zero.—D. Menchoff: The summation of series of orthogonal functions.—G. Fayet and A. Schaumasse: The next return of Borrelly's periodic comet (1905 II. = 1911 VIII. = 1918).—André Planiol: The calculation of the yield and heat balance of explosion motors.—Louis Breguet: The output from apparatus utilising the energy of the wind.—G. Bouligand: An approximate method for studying the movement of certain vortex rings.—A. Marcelin: Superficial solutions and the law of

Gay-Lussac.—René Delaplace: The extension of the law of Gay-Lussac to superficial solutions.—L. Riéty: The electromotive force of filtration. Aqueous solutions (1 per cent.) of various iron salts, forced through a glass tube under a pressure of 25 atmospheres, gave rise to potential differences between -0.070 volt and $+0.21$ volt. The results are discussed from the point of view of the rules given by Perrin. The solubility of the glass and the hydrolysis of the salts employed influence the sign of the electric charge.—E. Delcambre and R. Bureau: The propagation of short (Hertzian) waves. Details of the peculiarities noted for distances between 1500 and 10,000 kilometres in the propagation of short waves emitted by a transmitting station installed on the vessel *Jacques-Cartier*.—A. Perot and M. Collinet: The variation of the wave-length of the absorption lines of iodine with the density. The same weight of iodine was placed in two tubes of the same diameter but of different length, both being heated in the same electric furnace to 180° C. The variation of the wave-length was measured by a new interference method.—Pierre Daure: The determination of Avogadro's constant by means of the light diffused by ethyl chloride. The value found was $N = (6.5 \pm 0.65) 10^{23}$.—R. de Malleman: The diffusion of light and Kerr's constant.—L. Meunier and André Bonnet: The fluorescence of fisetine in Wood's light applications. Certain bark extracts taken up on acetyl cellulose give a characteristic fluorescence in Wood's light. The reaction has applications in analysis.—J. Laissus: The cementation of iron alloys by chromium.—R. Hugues: The annealing of electrolytic iron in a vacuum. The iron was heated in an electric furnace specially designed to reduce leaks due to porosity. Data are given showing the amount and composition of the gases evolved, and changes in magnetic and mechanical properties.—Gérard H. Lafontaine: Contribution to the study of the equilibrium of magnesium carbonate in ammoniacal solutions.—A. P. Rollet: The solution of nickel in sulphuric acid under the influence of the alternating current.—J. Errera and Victor Henri: The quantitative study of the ultra-violet absorption spectra of the dichlorethylenes. The *trans* derivative absorbs more than the *cis*, and the difference increases for the shorter wave-lengths. The absorption differences are the same in the pure liquids as in solution in hexane or in alcohol.—L. Royer: The regular joining of crystals of different species.—E. Rothé, J. Lacoste and Ch. Bois: Seismological observations made on the occasion of a violent explosion. Advantage was taken of the detonation of 3250 kilograms of high explosive in a mine to carry out seismological observations with two types of apparatus, a seismograph of the Mainka type installed in a mine five kilometres from the place of the explosion, and a 19-ton pendulum recently set up in Strasbourg seismological station 142 kilometres from the explosion. The latter instrument gave 2600 metres as the velocity of wave transmission.—P. Lavialle: The nutrition of the embryonic sac in *Knartha arvensis*.—Raoul Combes: The migration of nitrogenous substances from the leaves to the stems in the course of autumn yellowing.—F. van Gaver: Concerning the bony head and dentition of a young Asiatic elephant.—Emile F. Terroine, Mlle. S. Troutmann and R. Bonnet: The energy yield in the growth of micro-organisms as a function of the concentration of the nutritive substances of the medium and the food excess present.—Mme. L. Randoin, J. Alquier, Mlles. Asselin and Charles: The food equilibrium and relative proportions of mineral salts and glucides of a ration.—L. J. Henderson: The application of the nomographic method to the study of the

respiratory phenomena in the blood.—Caridroit and Pézard: The autonomous testicular growth in the interior of autoplasmic ovarian grafts in the domestic fowl—S. Kostytschew and A. Ryskaltchouk: The products of the fixation of atmospheric nitrogen by *Azobacter agilis*. The experiments lead to the conclusion that the *Azobacter* produces ammonia by the direct reduction of atmospheric nitrogen: the ammonia is afterwards utilised for the synthesis of amino acids.—A. Blanchetière: The colour reactions of tryptophane with aldehydes—Raymond Hamet: A new case of inversion of the effects of adrenaline.—René Fabre and Mlle. E. Parinaud: Study of the dissociation of the salts of narcotine and the best conditions for the extraction of this alkaloid in toxicology. It is possible to extract with organic solvents the whole of the narcotine from solutions of its salts. This is due to the marked dissociation of the salts in solution.—Vernadsky: The pressure of living matter in the biosphere—L. Fage and R. Legendre: The swarms of a polychaetal annelid (*Polyophthalmus pictus*) observed while fishing with a submerged light.—Arthur Grimberg: The treatment of external tuberculosis by a colloidal extract of Koch's bacilli. Details of the treatment are given; it has cured more than 50 per cent. of the cases and improved the condition of a further 25 per cent.—Et. Burnet: The differentiation of *Paramelitensis* by flocculation under the action of heat.

CALCUTTA.

Asiatic Society of Bengal, May 6.—C. J. George: Root sucking aphids of Coimbatore.—C. Chilton: The Amphipoda of Tale Sap. This is an instalment of the "Zoological Results of a Tour in the Far East." Eleven species are examined. Of these nine are the same as those from the Chilka Lake. One species is described as new. Two additional species from other localities are included in the report: one, *Grandidivella gilesi* from Patani River, a short distance to the south, on the same coast as Tale Sap; the other, *Colomastix pusella*, from Port Weld, on the other coast of the Peninsula.—D. N. Majumdar: The traditional origin of the Hos, together with a brief description of the chief Bongas (Gods) of the Hos.—Hem Chandra Das-Gupta: A few types of sedentary games prevalent in the Central Provinces. The plays described are *atharaguliata teora*, *dash-guli*, *gol-ekush*, *kaooa*, and *sat-gol*, and the description is based chiefly on the information gathered from a few villagers of Gosalpur, in the district of Jubbulpur.—H. Chaudhuri: A study of a disease of garden peas (*Pisum sativum*) due to *Sclerotium rolfii*. The causal organism was isolated from the soil and the plant tissues. Infection occurs through wounds only, and especially through wounds in the collars. The fungus was grown in various media, the P_H value ranging between 5 and 7.8; range of temperature, between 10° C and 33° C. Light is not an important factor in sclerotium formation, but dry atmosphere is favourable. Perfect sterilisation was obtained by autoclaving soil in pots (30 lb. for ten minutes).—Satya Churn Law: Local names of some birds of the Manbhum District.

SYDNEY.

Linnean Society of New South Wales, March 25 (Jubilee Meeting).—R. H. Cambage (Presidential address): Need for a botanical and soil survey of New South Wales. The growth and distribution of native plants are regulated by many factors, and therefore it is not possible to say definitely what a soil may produce without knowing all the facts governing its situation and accompanying conditions. Subject to climate, the geological formation is a most important factor in regulating the growth and

distribution of plants, and this is made manifest by the accordance in the changes of plant associations and of the rock formations. For ages the native flora has investigated the chemistry and physical characters of the soil in Nature's laboratory, and the result is available for our study and our benefit in the indigenous vegetation which for so long has been allowed to work out its own destiny unmolested by invasions of either fresh fauna or flora. Full advantage of the information at our disposal can be best achieved by a careful botanical and soil survey of our State so far as is reasonably possible.—W. F. Blakely: The Lorantheae of Australia. Part VI. Deals with 10 species and 8 varieties belonging to the subgenus *Dendrophthae*; two old species are rehabilitated, and 1 species and 4 varieties are offered as new.—G. D. Osborne: Geology and petrography of the Clarencetown-Paterson District. Part III. A study of the main glacial beds at Seaham. The total thickness of strata is measured at 1890 feet. Some structures, produced by the dragging force of moving ice, are characteristic of glacial beds developed close to an ice-front, in contrast with the facies exhibited by glacial deposits laid down at a distance from the ice-front.—Ida A. Brown: Notes on the occurrence of glendonites and glacial erratics in Upper Marine Beds at Ulladulla, N.S.W. The glendonites occur in the Ulladulla mudstones, the lowest beds of a marine series, on a horizon which may be correlated with the Huskisson beds farther north. They occur in mudstones closely associated with fossil beds, but have not been found in overlying mudstones which do not contain abundant fossils.—A. Philpott: On a remarkable modification of the eighth abdominal segment in *Lindera tessalatella* Blanch., with a description of the male and female genitalia.

VIENNA.

Academy of Sciences, April 30.—F. Werner: New or little-known snakes in the State Museum of Natural History at Vienna. Four new genera and eight new species of Colubridae are included.—C. Doeelter: The effect of pitch-blende on mineral colours. Radium produces effects in a few days, while pitch-blende requires some months.—R. Kreman and K. Zechner: On the influence of substitution in the components of binary solution equilibria. (xlviii.) The binary systems of azobenzol with acids. (xlix.) The binary systems of cinnamic aldehyde and salicylic aldehyde with phenols. (l.) Binary systems of acids and amines by R. Kreman, G. Weber and K. Zechner.—R. Kreman and A. Hrasovec: Electrolytic conduction in molten metal alloys. Attempts at repression of diffusion of metals in quicksilver by means of continuous current.—G. Weissenberger and F. Schuster: Organic molecular compounds. (x.) Vapour pressure curves. (xi.) Dolezalek's theory. (xii.) With H. Pamer. (xiii.) Chloracetic acids and penta-chlor-ethane.—J. Zellner: Contributions to the comparative chemistry of plants. (x.) Chemistry of barks Elm, alder, walnut, plane-tree have been examined. (xi.) F. Stern and J. Zellner: On *Sonchus arvensis*.—W. Konrad: Time curves of the Tauern earthquake of November 28, 1923.

Official Publications Received.

Scientific Papers of the Institute of Physical and Chemical Research. No. 23: On the Doublets and Triplets in the Spectra of different Elements. By Yoshikatsu Sugura. Pp. 31. 35 sen. No. 29: Sur la toxicité du thiophène pour le nickel catalyseur et une autre action du cuivre catalyseur. Par Benno Suke Kubota et Kiyoshi Yoshikawa. Pp. 33-50. 20 sen. No. 30: A Classification of Enhanced Lines of various Elements. By Masamichi Kimura and Gisaburo Nakamura. Pp. 51-69 +4 plates. 45 sen. No. 31: Classification of Enhanced Lines of various Elements. 2: Spectra of Intermittent Arc shunted by a Condenser. By Masamichi Kimura. Pp. 71-79 +1 plate. 20 sen. (Tokyo: Komagome, Hongo.)



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Universities as Centres of Chemical Research.

THE advancement of natural knowledge is the major, if not the exclusive, aim of all purely scientific societies, and to this aim they adhere as a rule very strictly. In recent times, however, events have happened which have led to a wider view being taken of the functions of science, and hence we discern an increasing tendency for presidential addresses to wander from the narrower paths of esoteric learning and to linger awhile in the more spacious avenues that lead not only to increased knowledge, but also to improved social welfare. Progress is determined by the interplay of many factors, intellectual as well as moral and physical, and leaders in the pursuit of new knowledge can do much towards its realisation if they possess their share of the tribal conscience and have the necessary courage to speak out.

Of the many problems that touch both science and social welfare, that of research is one of the most fundamental, and in selecting this topic for his presidential address to the Chemical Society, as well as for his skill in handling it, Prof. W. P. Wynne deserves our thanks and congratulations. In this address¹ he reconsiders in the light of recent happenings the observations and conclusions expressed by Prof. R. Meldola when he spoke from the chair in 1907. In the opinion of the latter the output of research work was not "representative of the productive capacity of the nation," and the "enormous submergence of research talent" then existing was due mainly to the few openings offered by industry, the low salaries paid to junior university teachers, and to poverty compelling promising students to leave the university immediately after graduation. The one bright spot in the somewhat dismal scene was the existence of scholarship schemes associated with the Royal Commissioners of the Exhibition of 1851, the Salters' Company and the Carnegie Trust, through which men of approved ability were enabled to carry on original work after finishing their college training.

Prof. Wynne's diagnosis of the present situation agrees in the main with that of his predecessor: both indicate that lack of sufficient funds is responsible for most of our present-day defects and deficiencies. In two tables Prof. Wynne presents statistics relating to the output and distribution of chemical research in the British Isles during the three sexennial periods 1901-6, 1908-13, and 1919-24. The original chemical memoirs published in the leading chemical journals and in the Proceedings of the Royal Society, and emanating from higher educational institutions, numbered 865, 1271, and 1464 in the respective periods.

¹ Journal of the Chemical Society, vol. 127, April.

To these totals the Universities of Oxford, Cambridge, and Manchester, together with the Imperial College (Royal College of Science and C.T.C.), contributed, collectively, 33.8, 36.5, and 34.8 per cent., the London colleges, modern English universities, and Welsh, Scottish and Irish universities, 57.8, 53.2, and 56.1 per cent., whilst the technical colleges accounted for only 8.4, 10.3, and 9.1 per cent. The persistent comparative sterility of the technical institutions is ascribed to the unenlightened outlook of the governing bodies concerned; and the approximate uniformity in the number of contributions from each of the three groups is regarded as accidental.

Interesting as the detailed figures given in the printed address undoubtedly are, their significance must not be overestimated. In the first place, it may be doubted whether numbers of papers published can afford an unambiguous index of research activity. The criticism is often heard that modern workers are far too prone to publish small instalments (scraps!) of work at frequent intervals, rather than to wait until their investigations have attained a reasonable degree of completeness. Publication of original research has become an almost indispensable condition of promotion in the academic sphere, and hence the young worker seeking notoriety and quick promotion may publish half-a-dozen small contributions in the same interval of time when a classical worker of the old school might have published only one. Secondly, the statistical method used by Prof. Wynne takes no cognizance of quality, and quantity without quality is of no greater moment in science than in art or morals. Whilst, therefore, we may agree that Prof. Wynne's figures warrant the conclusion that there has been a steady increase in the volume of chemical research—though not to the extent implied by the figures—there is nothing to indicate that there has been any corresponding increase in value. The statistical method very often breaks down when applied to things of the spirit.

In not repeating or endorsing his predecessor's opinion concerning the output of work being incommensurate with the productive capacity, Prof. Wynne takes a wise course, because the question of productive capacity in the intellectual sphere must be very largely a matter of conjecture, and unless we have some fairly accurate means of measuring, it must be wrong to predicate any quantitative relationship between output and capacity to produce. The belief may, however, be justified that, following the extension of educational facilities in our secondary schools, due to the enactment of the Fisher proposals, capacity for research is being increasingly developed, or rather, that those gifted with it are not being overlooked to the same extent as formerly. Unfortunately, secondary education shares

with university education the same handicap of lacking adequate financial resources, and therefore until better times arrive, both have to cut their coat strictly according to their cloth, compromise, and postpone enterprises of great pith and moment.

Prof. Wynne recalls that the university colleges passed their early lives in poverty, so that their administrators came to judge the success and the needs of departments by the number of students working in them, and to regard all departments as of equal value and importance; and these views still persist. The relatively high cost of maintaining laboratories remains an added handicap to scientific departments, and it is suggested that in allocating grants, more consideration should be given to the number of post-graduates engaged in research, and to the number of hours actually spent in teaching. Science demonstrators and assistants have to spend long hours in the laboratory, and therefore they should be given more free time for their own work. Since, however, the universal call for economy rules out any increases in staff, it is of fundamental importance to inquire whether greater efficiency could not be secured by abandoning the present policy of allowing each university to attempt to excel in many branches of pure and applied science, and by substituting therefor more localisation and greater concentration of effort.

For the old-established scholarship schemes for post-graduate research work Prof. Wynne has nothing but praise; the figures he gives show that far more scholarships are awarded for chemistry than for any other science. The Beit Memorial Fellowship and the Ramsay Memorial Fellowship Trusts have increased considerably the sums available for this work, whilst the Department of Scientific and Industrial Research, by giving maintenance grants for training in research methods, "has done a service to science and the country so great as to be almost incredible in the light of pre-War neglect." Its annual expenditure since 1920 in grants for research training in branches having industrial applications has been between 40,000*l.* and 50,000*l.*

The institution of the Ph.D. degree for research work was a war-time measure, originating in the desire to attract to our universities students from the Overseas Dominions and foreign countries who formerly would have studied in Germany. It was recognised at the outset that success of the scheme for such a degree would depend mainly upon the expenditure of large public funds to improve the equipment of our laboratories and to provide increased amenities for the students; such expenditure has, unfortunately, not been found possible. A serious blemish in the regulations for this degree is the non-provision of travelling scholarships for home students, as the

value to them of change of environment is very great. Since there is no immediate prospect that this defect will be remedied, Prof. Wynne suggests (1) that the Department of Scientific and Industrial Research should only renew its grants after the first year to students who migrate to another institution; (2) that the grants be renewable for a third year; and (3) that during the two years' absence from home the maintenance grant be increased.

Despite the acute and prolonged depression in trade, there has been a distinct change in outlook with regard to the employment of trained research chemists in industry, and for this the institution of research associations by the Department of Scientific and Industrial Research is largely responsible. Manufacturers, however, still complain of the inefficiency, from the works point of view, of the university-trained man; but, asks Prof. Wynne: Are the universities entirely to blame? What opportunities do industrial firms offer him for testing his vocation while there is yet time for him to make another choice? Is it not possible to allow selected students to spend some part of each long vacation in the works, not necessarily in the laboratory, but under foremen on the plant? The common objections relating to the violation of secrecy and interference with routine have been successfully overcome in Sheffield, where the presence of intending graduates is welcomed in the steel-works during the long vacation. There seems no valid reason why the example of Sheffield firms should not be followed in other centres and in other industries.

Finally, Prof. Wynne appeals to the Association of British Chemical Manufacturers to assist and co-operate with the universities in such matters. He recalls the fact that the Chemical Society took a leading part in launching the Association, but he did not mention, as he might have done, that the conferences of the chemical societies which led to its foundation were convened to consider the best methods, not only for promoting co-operation among chemical manufacturers, but also co-operation "between them and the teachers in universities, colleges, and technical schools." The Association has admittedly done good work for the manufacturers, and in support of Prof. Wynne we venture to express the hope that it will add to its laurels by working with and assisting institutions of higher education. As Prof. Wynne says, "University and industry—theory and practice—obviously must collaborate if the chemical industry of this country is to make headway in face of present difficulties"; indeed, without the co-operation of the universities, the industry can neither hope to prosper in times of acute international competition, nor fulfil its patriotic obligations in times of international strife.

National Art in the Stone Age.

Urgeschichte der bildenden Kunst in Europa, von den Anfängen bis um 500 vor Christi. Von Moritz Hoernes. Dritte Auflage, durchgesehen und ergänzt von Oswald Menghin. Pp. xix + 864. (Wien: Kunstverlag Anton Schroll und Co., 1925.) 30 gold marks.

ALTHOUGH written history begins in Europe two thousand years later than in Egypt or Mesopotamia, the archaeological record is nowhere longer or more continuous. Art is more the object of the archaeologist than the philologist; and in this domain Europe is exceptionally rich. The men of the Old Stone Age decorated bones or cave walls with marvellous drawings which recall to life an extinct fauna. But the naturalism of palæolithic art passed away with the advent of more modern climatic conditions; in France and Spain, the centres of quaternary art, only conventionalised and æsthetically worthless survivals are to be found on the walls of Copper Age cave-shelters and dolmens. Only in the extreme north did a naturalistic art, stylistically if not genetically akin to that of the cave-men, persist throughout the New Stone Age among backward food-gathering tribes. From that period, which saw the establishment of food-producing economy, no artistic products have elsewhere come down to us save geometrically decorated vases and rude clay figurines.

The same geometric character pervades continental art in the Bronze and early Iron Ages. But in the Ægean in the seventeenth century B.C., a new and deliberate naturalism arose under the shadows of the Cretan palaces, only to fall a prey to conventionalism and eventually to become geometric in the "Greek Middle Ages," as Hoernes happily describes the Late Mycenaean and Dipylon periods. The final revival of naturalism begins in the city-states of archaic Greece, and Etruria, then among the Celts of La Tène, and finally among the Teutons in the first centuries of our era. Hoernes saw in these transformations the reflection, not of racial, but of economic and social changes. The primitive naturalism was proper to the parasitic life of hunters. Geometric styles correspond to the symbiotic economy of peasants, and in the permanence of their designs betray the prominent part played by women in the new industries. A synthesis of the foregoing moments in a class-society wherein a "parasitic" layer of rulers, priests, and warriors has been superimposed upon the peasantry evokes the conscious naturalism of Middle Minoan Crete or La Tène. With these masterly generalisations the Viennese professor summed up abstractly the artistic evolution of our continent.

In presenting the evidence on which these conclusions

were based, Hoernes adopted an almost equally abstract method. Writing in 1914, he did not believe in the possibility of identifying racial groups by archaeological data. In the ten years since his death, the immense progress of science has left the prehistorian no alternative but to adopt the concrete methods of the historian. His characters are indeed nameless and the individual still eludes him, for in the epoch with which he deals the individual was still merged in the collectivity. Prehistoric art is like modern peasant art; it is far more the product of the group, the embodiment of its æsthetic traditions, than the creation of an individual artist. On the other hand, just as peasant art in Brittany is distinct from that of the Ukraine, so the several styles of geometric decoration on neolithic pottery must be regarded as embodying the ideals of specific racial groups. Hoernes' pupil and successor, Prof. Menghin, is animated by this principle throughout the two hundred pages of his appendix. Thus even in the Old Stone Age the "impressionist" scenes painted on the rocks of southern Spain may be contrasted with the isolated realistic figures depicted farther north. This contrast illustrates the distinction between a race newly come from Africa (the Capsians) and more Eurasiatic stocks.

In the New Stone Age the archaeological map of Europe discloses a veritable mosaic of cultural groups. The sharpness with which these nameless peoples stand out, the precision with which their migrations can often be plotted, will come as revelations to English readers. Pottery is now the best guide to their identification and the principal vehicle for their artistic self-expression. Thanks to Prof. Menghin, we now have for the first time a complete and reasoned account of the ceramic styles and their interrelations. The loesslands of the Danube valley are occupied by peaceful peasants. Fine pottery adorned with spirals and mæanders defines the extent of their colonies; derivative types growing into local styles mark their gradual expansion to Poland, south Germany, and Belgium. From the west (probably from Spain, for brachycephals are found there despite Menghin's statement to the contrary) a short-headed race of armed traders introduce their bell-shaped beakers into central Europe, there mingle with a Nordic tribe, and eventually invade Britain. But the real plot of European prehistory is the victorious expansion of the "Nordic culture." The latter, Menghin frankly attributes to Indo-Germans (*i.e.* Indo-Europeans or Aryans); for he is a Germanist albeit a temperate exponent of theories often travestied by too ardent advocates. The submergence or absorption of the Danubian peasant art by that of Nordic invaders is in any case patent. It provides a truly historical explanation for that contrast

between peripheral and tectonic styles of decoration upon which Hoernes based his whole treatment of neolithic pottery; for the metopic division of the vase-surface was as characteristic of the North as the free ornament was of the Danube valley.

Here, as in the analysis of west European cultures, the concentration on ceramic evidence imposed by the plan of Hoernes' work tends to hide difficulties. The internal incoherence of the "Nordic culture," notably the opposition between the separate-grave folk of inner Jutland and the megalith-builders on the Danish coasts, would have become more glaring had weapons and ornaments been considered. Conversely, chronological difficulties have been evaded by giving the "Caucasian pottery" the status of an independent group. It can, however, only rank among the subdivisions of Menghin's Nordic group; direct genetic relationship is demonstrated *inter alia* by the very peculiar type of tomb in which similar vases occur both on the Saale and on the Kuban (Menghin's printer has consistently confused this river with the Iron Age site of Koban). If the high antiquity of the latter tomb really precludes its attribution to a clan hailing from central Germany, the only alternative is to invert the direction of the journey.

If, however, the warlike Nordics must claim the attention of the historian, they have little to offer to the artist. On the other hand, the peaceful peasants of the south-east have left us monuments of real beauty—magnificent painted vases. The Thessalian group is already familiar; this well-illustrated account of the Transylvanian-Ukrainian vases and figurines will be all the more welcome. We would, however, suggest certain corrections. The most important site yet excavated—Erösd—is omitted. Now the inhabitants of this Copper Age village, nestling among the mountains of Transylvania—the ancient El Dorado of central Europe—not only decorated their vessels with polychrome spirals and mæanders but also adorned the walls of their substantial houses with frescoes and plaster mouldings. Then pottery virtually identical in technique and decoration with that of Erösd appears intrusively in a corner of Thessaly. How can Menghin deny that this intrusion marked an invasion from beyond the Balkans? In Thessaly this genuine painted fabric gives place to the curious "crusted" ware on which the colours are applied only after the burnishing and firing of the vase. The same technique is encountered in the Danube valley from Serbia to Moravia. But Hoernes and Menghin have not distinguished it from true painting, and so have missed the essential cultural continuity between Thessaly and the Danube valley at this period. In fact they treat the Danubian crusted ware as older than and partly the ancestor of

the painted pottery of Transylvania, whereas the stratigraphical sequence in Thessaly would suggest just the opposite relation. Finally, the curious way in which stylised animals come to figure among the geometric designs of the latest painted pottery in Galicia and the Ukraine is surely a phenomenon worthy of note in a history of art. However, the painted pottery appears with meteoric brilliance only to vanish utterly in the night. Perhaps the vase-painters were submerged by the same Nordic flood that had overwhelmed the peasants of the Danube valley.

The remaining ceramic groups distinguished by Menghin are of less artistic or historical significance. He finds no continuation for the mesolithic wares of the Danish kitchen-middens and Campigny and, with less justification, isolates the neolithic pottery of Crete from its successors and neighbours. The artistic capabilities of the rude hunters of the extreme north are better expressed in their carvings than in their coarse vases. Finally, all the wares of western Europe and north Africa are classed together in one admittedly amorphous group. Incidentally, while flattered by the prominence accorded to English neolithic wares in the last-named group, we deplore the neglect of the richer Scottish material.

As a whole, this book with its 1462 illustrations constitutes a veritable corpus of neolithic pottery; and the art of the later periods and of the Ægean is treated with no less thoroughness and lucidity. If there be room for differences of opinion on isolated points as indicated above, that is but natural in a pioneer work on a young science; no such detailed or comprehensive survey of European prehistory has ever before been attempted in any language.

V. GORDON CHILDE.

The Study of Corals.

An Introduction to the Study of Recent Corals. By Prof. Sydney J. Hickson. (Publications of the University of Manchester, Biological Series, No. 4.) Pp. xiv+257. (Manchester: At the University Press; London: Longmans, Green and Co., 1924.) 25s. net.

AMONG living zoologists no one is more competent than Prof. Hickson to write a book on corals. Many years ago he made acquaintance with coral organisms in their natural surroundings; and since then the Anthozoa, the group to which corals belong, have been

The author's definition of the word "coral" will probably excite surprise by its breadth. He uses it for marine sedentary organisms, animal and vegetable, "that produce a solid skeletal (or more accurately *shell*) structure of calcium carbonate which persists as such entire, after the death of the living organisms that produced it." The things included in the term corals are therefore the calcareous marine plants, certain Foraminifera and sponges, the madreporarian corals, certain Alcyonaria (such as the precious coral) and Hydrozoa, and also some genera belonging to the Polyzoa and Annelida. But has the term coral ever been used, even popularly, in such a wide sense as this? In practice Prof. Hickson widens it still further by including Gorgonia and the antipatharians, the skeleton of which is not calcareous at all. Parenthetically, would the skeleton of the precious coral ordinarily be termed a shell structure, and is it "strictly speaking, an outside support or exoskeleton" (p. 17)?

We shall not quarrel very seriously, however, with the definition proposed by the author. He has had the happy idea of describing for us, in an easy and delightful fashion, a number of organisms which have interested him, and of illustrating his descriptions by choice examples of the photographer's art. He is in want of a term under which these can be subsumed; and "coral" is at least not altogether inappropriate—is as suitable, at any rate, as any single word can be.

One other objection to the author's use of terms. We shall not all agree that "the conception of individuality has no relation to the structure or function of the parts but to the discontinuity of the living organism as a whole from other living organisms"; though it may perhaps be true that "the Alcyonium or the Tubipora as a whole is, *in common language* (italics the reviewer's), the individual, and the polyps parts or organs of the individual."

Coming to the contents of the volume, the introductory chapter, "On the Use of some Words," deals with the meaning of "coral" and "individual," which we have just alluded to, to that of "polyp" (which Prof. Hickson extends to the zooids of the Polyzoa) and "zoophyte." Chap. ii. gives a short account of structure, especially of that of an anthozoan polyp, and classification; the "Additional Note on the part played by sponges" (pp. 248-257) is a valuable addition.

of the mesenteric muscular bands, that "in the cases of the directive mesenteries these ridges are on the surfaces *opposed to each other* (italics the reviewer's), that is to say, they face outwards" (p. 33). The interesting association of *Heterocyathus* with the gephyrean *Aspidosiphon* is described on pp. 39-40.

Alcyonarian corals are described in Chap. v.; *Coralium*, *Tubipora*, *Heliopora* and *Gorgonia* are treated at some length, a number of other genera more cursorily. Chap. vi. disposes of the antipatharians in a few pages; and successive chapters are given to the hydrozoan corals—*Millepora* and the *Stylasterina*; polyzoan corals; foraminiferan and poriferan (*Merlia*) corals and annelid worm tubes; and lastly coral Algæ—the red seaweed corals and green seaweed corals.

The penultimate chapter is something of a disappointment. We feel that in a volume on corals by Prof. Hickson we had a right to expect more than 17 pages on coral reefs; we would willingly have sacrificed the worm tubes, sponges, and Foraminifera, as well as the Algæ, to have had an equivalent here. The author's very first words—the opening sentences of the preface—speak of the fascination, the charm, and the enduring interest of the life of the reefs; but he gives us little more than a brief account of the composition and form of the reefs, and of the theories of their formation.

The last chapter gives an agreeable account of the trade in black and red coral from the earliest times. Among much other interesting information we are told that some years ago a great bronze shield, supposed to belong to the Early Iron age, was found in the bed of the river Witham in Lincolnshire, bearing five large pieces of red coral, each circular in outline, ground to form a convex surface and polished; and that armour decorated in a similar way has also been found in Ireland. Even in the eighteenth century red coral was much esteemed as a drug, being given, for example, in a paste along with crabs' eyes and other things, for fevers in children.

The book is obviously intended to be of use to the intelligent layman, who has only the most elementary acquaintance with physiology and anatomy. But it will certainly be read largely by others; not only by and honours students of special study of the Anatomy for zoological amateurs, and the cases

Morphology of the Alimentary Canal.

Vorlesungen über vergleichende Anatomie. Von Prof. Otto Butschli. Lieferung 4: Ernährungsorgane. Herausgegeben von F. Blochmann and C. Hamburger. Pp. iv+380. (Berlin: Julius Springer, 1924.) 6.45 dollars.

THIS is a compilation of a kind which we expect from the patient industry and passion for orderly arrangement of the German scientific writer. It is a mine of information from which details of the structure of the alimentary canal of a very large number of animals can be extracted with a minimum of trouble. To the English zoologist it will appeal most because it is illustrated with the thoroughness which the German author rightly believes to be necessary, and the illustrations are selected with characteristic care. A large proportion of them are entirely new to text-books, and many of them are from original drawings of Bütschli. But for the fact that they are sometimes rather too small to be easily understood, they are really excellent and a substantial justification for the publication of the book.

When we consider the text, however, there arises the question as to how far a morphological encyclopædia of this kind is valuable to zoologists. It has, indeed, occurred to the authors that a certain amount of physiological information should be incorporated into their work. This is, however, relegated to paragraphs of small print for the most part and, even making allowance for the scantiness of present-day knowledge, is insufficient. The alimentary canal lends itself less to purely morphological comparisons than any other system of the body. It is so plastic that astonishing differences may exist between closely related animals which are obviously related to differences in diet. To take an example, the excellent morphological account of the alimentary canal of the Mollusca seems incomplete to the reviewer because the varied habits and physiological characters of such forms as nudibranchs, heteropods, boring lamellibranchs, and many others are never mentioned. The initiated may be able to fill up the gaps, but there is not much help for the student who wants to know how much of the form is related to function. Nor is there usually more than casual reference to the histology of the various alimentary organs. This is no doubt outside the scope of the book, but it may well be claimed that, in the study of the histology of the alimentary canal, as in the study of the histology of any other system of the body, the morphological account is of little use unless it is supplemented by a physiological account.

morphology and comparative physiology as well (like the stupendous Winterstein) do everything but compare. They present an array of densely marshalled facts through which the reader travels despairingly, being quite unable to see the wood for the trees.

Pottery and Porcelain.

Pottery: being a Simple Account of the History of Pottery and a Description of some of the Processes employed in its Manufacture. (Pitman's Common Commodities and Industries.) By Charles J. Noke and Harold J. Plant. Pp. xi+136. (London: Sir Isaac Pitman and Sons, Ltd.) 3s. net.

Pottery and Porcelain: a Handbook for Collectors. Translated from the Danish of Emil Hannover Edited with Notes and Appendices by Bernard Rackham. Vol. 1. Europe and the Near East: Earthenware and Stoneware. Pp. 589+7 plates. (25s. net.) Vol. 2. The Far East. Pp. 287+2 plates. (18s. net.) Vol. 3. European Porcelain. Pp. 571+2 plates. (25s. net.) (London: Ernest Benn, Ltd., 1925.)

THE first-mentioned of these works might, happily, serve as an introduction and technical aid to the important and comprehensive handbook with which it is associated in this notice. Its authors have accomplished their modest scheme with such ability and success as to give the reader who is not a potter an insight into the practical methods which are followed in the manufacture of the multifarious articles of pottery and porcelain, whether intended for everyday use or as the embodiment of precious artistry, which men treasure in our day even as they seem to have prized and collected such things for unnumbered years. The clarity and simplicity with which the technical information is presented—together with excellent illustrations and photographic reproductions of the tools, methods, and processes used by the Staffordshire potters of our time—deserve warm commendation. Apart from the immediate aim of the writers, which has been to aid the student-workman who is engaged in the craft, every collector of pottery and porcelain who wishes to acquire clear ideas of how the precious objects he treasures were made will find this a handy and reliable little work of reference, to be used in conjunction with those voluminous histories of the potters' achievements in which technical matters are not always treated with such simplicity and precision.

The scholarly and comprehensive handbook for collectors compiled by the late Dr. Emil Hannover and here translated for English readers by Mr. Bernard Rackham, one of our foremost museum authorities—who also contributes greatly to the value of this English

edition by an extensive series of explanatory notes and addenda—displays at once the strength as well as the weakness of any survey, aiming at completeness, of such an extensive field by any single author. Undoubtedly, Dr. Hannover's narrative gains in unity of purpose and of outlook because all the ideas have been distilled through the alembic of a single, well-informed mind. It is, however, almost inevitable that certain sections of any work that proposes to set forth the complete history of an artistic craft that is coeval with civilisation, which must therefore comprehend all the fictile arts of the Greek, Persian, Chinese, Japanese, and European peoples—to mention only the more important—should be less satisfactory in judgment and understanding than others. Having entered this modest caveat, the reviewer is free to appreciate the fare so abundantly set forth for the reader's delectation and instruction.

It is only possible in the space at our disposal to direct attention to the more salient features of the work, for as a comprehensive bibliography of ceramic literature is included, the reader who requires fuller information on any specific point will readily find the most authoritative sources to which he may turn for further enlightenment. Another feature, which adds to the completeness of the work and its consequent value to collectors, especially to those who have but recently acquired that delightful hobby, is the valuable descriptive notes and illustrations of "forgeries"; for though, as Dr. Hannover says, "the really dangerous counterfeits can only be distinguished by acquiring a thorough knowledge of the genuine things," it is possible to prepare one's self for meeting the spurious thing and its recognisable defects.

It seems but natural that one should instinctively turn to the volume which deals with the ceramic productions of the Far East, especially as for the last two centuries these Oriental wares have exercised such a powerful influence on all European pottery and porcelain, with the exception of the stonewares. In the few years that have elapsed since the close of the War, all competent observers must have been impressed with the number of artist-potters, working on their own account or in association with old-established factories, in all European countries, who have turned with a fresh, often a childlike eye to the older treasures of Chinese and Japanese skill and are now exhibiting their pleasure by the production of works which, though frankly European in style, are not ashamed to acknowledge the sources of their technical inspiration.

In the same way, Dr. Hannover, having absorbed all that has been written by the foremost authorities, gives us a condensed but eminently readable account of the growth and development of the ceramic arts in

the Far East in his second volume. As to the spirit in which he entered into his work, one cannot do better than quote a short section from his summary of the position of the art in China at the end of the fourteenth century :

"For if a piece of five-coloured Ming or of K'ang Hsi blue-and-white often appeals with greater sweetness to the senses than almost any other fruit of human craft and genius, it is due to the fact that the object itself, by virtue of a continuity hardly conceivable in any but the most conservative country in the world, is the product, ripened with infinite slowness and infinite sureness, of traditions more than a thousand years old. It is to the oldest pottery, here briefly described, that we owe this tremendous acknowledgement."

The reader will turn to Vol. I., which treats of the earthenwares and stonewares of Europe and the Near East, with the assurance that the author, from his position as Director of the famous Museum of Industrial Art at Copenhagen, will have a first-hand acquaintance with the work of the European factories, particularly with those of the northern and eastern countries, of which British museums can scarcely be said to contain thoroughly representative collections. As Mr. Rackham notes in his "foreword,"

"These sections in Vols. I. and III. relating to the potteries of the Scandinavian region, although treated on a somewhat fuller scale than the remainder of the book, have been allowed to stand unshortened. No full accounts of the Northern wares have ever been published in English; much even of the author's work in this section of the book embodies entirely new research which had never before been published in any language. It seemed therefore essential that his valuable contribution to ceramic history should be given in full to the English reader."

All of which is very handsome of Mr Rackham, especially as Dr. Hannover treats our British pottery in very summary fashion, and expresses in round terms an idea that I have often heard from keepers of Continental museums when he writes :

"for, as we have many times noted, when speaking of conditions on the Continent, it was English earthenware in the classical and insinuating form given to it especially by Wedgwood and Leeds that was the doom of the old faience. And not of faience only—this great English industry put an end to the development through more than two thousand years of *all* the ceramic arts, porcelain not excepted."

The volumes are profusely illustrated with half-tone plates, generally of admirable clearness, and, in addition, there are a few coloured plates of great beauty. Such plates as that of the Marieberg Tureen (Plate VII., Vol. I.) will be new to the majority of English collectors.

WILLIAM BURTON.

Ubique.

The Roll of Honour of the Institution of Electrical Engineers.

Pp. xv + 330 + 40 plates + 6 maps. (London: The Institution of Electrical Engineers, 1924.)

THIS very handsome volume contains biographical notices of the 162 members of the Institution of Electrical Engineers who lost their lives in the War, 1914–1919.

The extremely able summary of the origin and causes of the War, as well as all the biographical notices, have been written by Bt.-Lieut.-Colonel W. A. J. O'Meara, C.M.G., (late) R.E., and his task, which took him no less than five years to accomplish, has been performed in a truly admirable way. All the notices give details of the particular member's life prior to the outbreak of War, followed by a comprehensive and sympathetic summary of his service in the field. Further, in all cases, every action mentioned is linked up with the actual operations that were in progress at the time, so that a true perspective is maintained and continuous interest is ensured. Nearly every notice is accompanied by a well-reproduced portrait, and in a pocket at the end are placed six excellent maps of the various theatres of War, on which the operations can be readily followed.

On analysing the services of these 162 members, it is seen that in August 1914 only five belonged to the old regular fighting Services, one each to the R.N., R.A.F., and R.A., and two to the R.E. Of the others, one cannot fail to be struck by the fact that, despite their specialised engineering education, the Royal Engineers did not claim more than 40 of them. The remainder were allowed to join almost every branch of the Service, and they are found in the Royal Navy, yeomanry, artillery, infantry, and Air Service; with trench mortars, in the Machine-Gun Corps, in the Army Ordnance Department, Army Service Corps, Friends' Ambulance Unit, on the Embarkation Staff, in the Indian Defence Force, and with the Expeditionary Forces from Canada, Australia, New Zealand, and South Africa. They performed technical duties in the Anti-Submarine Division, with searchlights, and in sound ranging. Nevertheless, in reading their biographies, it is impossible not to recognise the fact that in whatever branch these men served, their knowledge of engineering was always valuable, and they were able to make use of it in many ways, both for the assistance of their own unit and in furtherance of whatever operations were being undertaken.

To take a few instances: One member, a student of 1912, Lieut. (later A/Major) D. G. Trouton, belonged to the R.F.A. (Special Reserve) at the outbreak of War, and he was at once posted to the 2nd Divisional

Ammunition Column, and with it proceeded to France in August 1914. He served throughout the retreat from Mons and subsequent advance to the Aisne, and he was seriously wounded during the battles of Ypres 1914. Later, he served through the Suvla operations with the 11th Division, until he was invalided with dysentery in November 1915. Rejoining in France, he took part in the battles of the Somme 1916, and was again seriously wounded. Returning again to France before the close of the year's fighting, he was in the battle of the Ancre Heights. In 1917 he was engaged in the battle of Messines and then in the battles of Ypres 1917. Shortly after promotion to A/Major, he was killed in his battery position in the first battle of Passchendaele on the day before his twenty-fourth birthday. He well deserves the stirring pages devoted to his long war record and gallant services.

The spirit shown by members of the Institution on the outbreak of hostilities is well illustrated by the case of Rifleman A. T. Mahon. A student in 1913, he at once offered his services. Rejected on chest measurement, he underwent a course of physical exercises and offered himself every month until he was finally accepted in February 1915. He then joined the 5/London Regiment (London Rifle Brigade). He went to France in August, and in due course joined the signal section of his battalion. His division (56th) took part on July 1, 1916, in the ill-fated attack on Gommecourt. At the height of the fighting, his battalion being isolated and ammunition running low, the signallers were ordered to establish communication by wire with the troops. To carry out this task Mahon and a comrade, taking their instruments, at once went forward to what was almost certain death. That night Mahon was reported missing, and afterwards he was presumed to have been killed. Devotion to duty of this nature is sometimes awarded a very high distinction, but Mahon's gallantry remains its own reward. It must have given Col. O'Meara a melancholy satisfaction to save this fine deed from oblivion.

The Dominions, too, are well represented in this Roll of Honour. Lieut. (Hon. Capt.) A. T. Hayne, D.S.O., D.F.C., who was born and educated in South Africa, had come to England in 1913 to take a four years' course in electrical engineering. By the time the War broke out he had already acquired a thorough knowledge of internal combustion engines, which proved invaluable to him later on. He joined up in January 1915, and after serving in the autumn at Helles with the armoured cars, he transferred in 1916 to the R.N.A.S., and went to France in January 1917. In this theatre he performed splendid service, for he had to his own credit twenty enemy machines brought down in single combat, and in one set of operations he carried

out no less than forty-eight special missions. Unfortunately, in April 1919 a machine that he was testing crashed and he was killed instantaneously.

Another overseas member, Major H. C. Symmes, was born in Canada. He took the five years' course in mechanical and electrical engineering at McGill University. Later he joined the Canadian contingent and went with it to the Boer War. After the contingent returned, Symmes remained behind in Pretoria working on the staff of the Transvaal railways, and in 1911 he became Inspector of Machinery and Electricity in the Mines Department. He at once volunteered for service on the outbreak of War, and, in command of a company of the Witwatersrand Rifles, he served in the campaign in German South-West Africa. He then proceeded to Europe with the South African Brigade, and in July 1916 he took a reinforcing draft to France. In October 1916 he participated in the heavy fighting for the Butte de Warlencourt, in which operations the South African Brigade lost 45 officers and 1150 other ranks. Major Symmes was killed on the first day of the battles of Arras 1917, whilst gallantly leading his men.

Our allies also furnish three members in this Roll of Honour. Belgium is represented by Caporal W. R. E. Claeys, and France by Sergeant J. H. Labour, and l'Inspecteur-Général G. P. Seligmann-Lui, Director-General of Telegraphs and Telephones at G.Q.G., and all three have most distinguished civil and military records.

A copy of this Roll of Honour has been sent to each member's next of kin, and the Institution is indeed to be congratulated on the form of memorial it has chosen, with the idea of perpetuating the names of its members who died in the War and ensuring that their services shall live for evermore. Men who came from the ends of the earth to fight for their country, who placed patriotism before mere private profit, using their engineering skill and finally giving their lives for the cause, "the wide earth is their sepulchre."

Fatigue and other Properties of Metals.

- (1) *The Fatigue of Metals.* By H. J. Gough. Pp. xx + 304 + 14 plates. (London: Scott, Greenwood and Son, 1924.) 25s. net.
- (2) *Grundbegriffe der mechanischen Technologie der Metalle.* Von Dr. Georg Sachs. (Die metallische Werkstoff: Gewinnung, Behandlung, Veredlung. Band 2.) Pp. x + 319. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1925.) 13 gold marks.

(1) **M**R. H. J. GOUGH, a member of the staff in the Engineering Department of the National Physical Laboratory, has written a book on a subject to which he has himself made valuable original

contributions. This in itself gives it unusual value, for he writes with first-hand knowledge and authority. The title itself needs some explanation. The phrase "fatigue of metals" has long been used by engineers to denote phenomena leading up to the failure of metals under repeated stresses. The original underlying idea was that, under these conditions, the metal gradually became "crystalline," and that this was the primary cause of its breakdown. Modern research, however, on the crystalline structure of metals has shown that this is not the case, that no crystallisation occurs, but that the failure takes place because the metal ultimately breaks on a comparatively few planes which, on account of their size, give the appearance of crystallinity. As the author points out, the term is far from ideal, being both indefinite and rather misleading. He tells us that "our ideas of fatigue phenomena must frankly be admitted to be in the melting pot," and that "no research yet published has been sufficiently fundamental" to characterise satisfactorily this phenomenon.

In spite of this, however, Mr. Gough uses the term because it is so widely employed, but he defines it quite generally as "the behaviour of metals when subjected to repeated stresses." Examples of this are numerous, and include the axles of railway carriages and trams, crank shafts and connecting rods of reciprocating engines, hulls of steam-ships, motor-car springs and chassis, railway rails and tyres, shafts of steam turbines, teeth of pinions, valve springs, and many machine details.

The subject is of supreme importance on account of the present-day tendency to employ high working stresses and speeds in the design of machines and prime movers. Dr. Stanton, who contributes a foreword to the volume, remarks that Rankine clearly anticipated in many ways the results of research in this field, and that since the publication of Wöhler's experiments in 1860-70, investigation has proceeded in two main directions. On one hand, methods of determining the fatigue range of stress on material under given conditions have been so much expedited that the whole determination is now only a matter of an hour or two; accordingly, this has brought the fatigue test within the scope of standard tests of materials. Twenty years ago it took so long to perform that it would have been quite impossible to include it in any specification. On the other hand, attempts to try to understand fatigue phenomena have resulted in important contributions being made to our knowledge of the crystalline structure of metals. Mr. Gough's contributions have been in both these fields. His book is the first attempt which has been made in Great Britain to study the subject as a whole, and he has performed a valuable

service in bringing within its scope a careful consideration of the experimental data published in many journals. Among the subjects dealt with in its ten chapters are repeated-stress testing machines, endurance limits of metals, elasticity and its relation to fatigue, the fracture of metals under statical and repeated stresses, theories of fatigue failure and methods of rapidly determining fatigue ranges. It deserves to be widely studied by engineers and metallurgists.

(2) Not unrelated to the previous work is that by Dr. Georg Sachs on "The Mechanical Technology of Metals." This also is a book written by an engineer, a member of the staff in the Kaiser-Wilhelm-Institut für Metallforschung. The first section is concerned with the mechanical behaviour of solid metals, especially with reference to elastic properties, changes of form, tensile, compression, and torsion tests, cohesion and hardness. Then follows a consideration of metallic crystals and their properties. Upwards of twenty pages are devoted to the special properties of single metallic crystals. These are contrasted with the properties of crystalline aggregates in the following section. The author states that in their elastic behaviour, single crystals are sharply differentiated from crystal aggregates in that they are free from hysteresis, and in support of this quotes the work of Warthenberg and Geiss on the crystals of tungsten and zinc. Later sections deal with methods of hardening and softening and a consideration of theories put forward to account for these phenomena. The last section of the book treats of some special properties of pure metals and alloys. The author is an engineer who has evidently been quick to appreciate the fact that there are great possibilities of new knowledge being obtained in the study of the mechanical properties of single metallic crystals.

H. C. H. C.

Our Bookshelf.

The Physics of the Developed Photographic Image. By F. E. Ross. (Monographs on the Theory of Photography, No. 5.) Pp. 217. (New York: D. Van Nostrand Co., Rochester, N.Y.; Eastman Kodak Co.; London: Kodak, Ltd., 1924.) n.p.

IN 1921 the Eastman Kodak Co. commenced the publication of monographs on the theory of photography, and this book by Mr. Ross is the fifth of the series. The work will appeal chiefly to astronomers and those interested in astronomy, since it is mainly with the questions of astronomical photography that the author is concerned. It is divided into six chapters which deal with "The Developed Silver Grain," "Graininess," "Astronomical Photographic Photometry," "Sharpness and Resolving Power," "The Mutual Action of Adjacent Images," "Film Distortion

and Accuracy of Photographic Registration of Position." Throughout the book the historical development of the subjects treated has been emphasised in a way that makes it easier for the reader with no previous knowledge of the subject to understand the fundamental problems involved. The chapter on graininess, by A. C. Hardy, is exceptionally well written, and should be of interest to all those engaged on problems involving great magnification of photographic negatives, as in cinematography. Chap. ii contains a vast amount of information on the methods of astronomical photographic photometry, *i.e.* the method of obtaining the magnitude of a star from its image as impressed on the plate, and, with the remaining chapters, shows to the reader what a host of pitfalls and difficulties in astronomical photometry arise owing to the complicated structure of the photographic plate.

Mr. Ross is to be congratulated on having brought together into one volume a mass of information largely unknown to the average photographic worker, and of great value to the astronomer. The criticisms which can be made are not serious. In a volume with such a comprehensive title one would have expected to find the question of light scatter by the negative treated in relation to the well-known fact that the photographic density depends on the degree of diffusion of the light, etc.—a fact which has caused uncertainty in density measurement ever since it was introduced in 1890 by Hurter and Driffield. The more mathematical parts of the book suffer in the same way as most of these monographs have done, though not to the same extent as some, in that the text is sometimes difficult to follow. The photomicrographs are very fine; especially will they be appreciated by those who know the difficulty of photomicrography at high magnification of cross-sections of emulsion layers

F. C. TOY.

College Manual of Optics. By Lloyd William Taylor. Pp. ix + 236. (Boston, U.S.A., and London: Ginn and Company) 12s. 6d. net.

THE co-ordination of laboratory and class work is usually a problem of much difficulty in physics courses above intermediate standard, so that not infrequently there is little if any attempt made in this direction. The manual under notice sets out to bridge the gap between the two lines of study. It would obviously be impossible to treat both comprehensively in one volume of reasonable dimensions, and probably the most serious criticism to which the book could be subjected would be in respect of the matter omitted from it. Undoubtedly the most interesting section is that dealing with diffraction and interference effects observed with one and two slits. The essential differences between the two phenomena are clearly brought out, and Michelson's astronomical application of the latter is for once intelligibly presented and, further, strikingly illustrated by a laboratory experiment. The section on the Michelson interferometer is particularly good, as one has a right to expect from a book associated with the University of Chicago. Yet curiously enough there would appear to be no mention of the remarkable achievements of the instrument in optical testing work. The Fabry-Perot interferometer receives something less than adequate treatment; the student would probably obtain a quite erroneous idea

of the relative importance of the two instruments in modern high-resolution work. The echelon spectro-scope is not even mentioned, but no doubt this is because it is not usually met with in a laboratory course.

There are one or two points in the chapter on polarimetry to which exception can be taken. For example, the Laurent polariser (which is described here) has long given place to the Lippisch (which is ignored) as a research and commercial instrument. Again, contrary to what is stated, a yellow light filter is indispensable when a sodium flame is employed as source, at any rate for considerable rotations. It is surely not permissible to employ white light and a filter in any polarimetric measurements; the filter which will supply even approximately monochromatic light under such conditions has unfortunately yet to be invented. But these are minor blemishes, more than counterbalanced by many merits. It is a stimulating and original book, refreshingly lucid and direct in its methods, and provides without doubt a very valuable supplement to the ordinary text-books of optics.

The Central Caribs. By William Curtis Farabee. (University of Pennsylvania: The University Museum. Anthropological Publications, Vol. 10) Pp. 299 + 40 plates (Philadelphia: University Museum; London: Bernard Quaritch, Ltd., 1924.) 44s. net.

THIS sumptuously equipped and splendidly illustrated volume has all the virtues and some of the defects of the so-called "survey-work," that is, work carried on over an area very extended, relative to the time devoted to its study. Hence the traveller, unable to learn the native languages, has to rely on interpreters and informants, he has to collect material objects and to be satisfied with observations which can be made rapidly and yet correctly. It is possible in such work to obtain a clear idea of the material culture of a tribe and a general view of their beliefs and social organisation, to map out the differences between the peoples of the region studied; to signal strange customs of outstanding importance. The insight into the native ways of life and modes of thought, however, the intimate perspectives of their moral outlook, of their *Weltanschauung*, and of their social order are given only to those who have the opportunities and the patience indispensable for the study of the local idioms and for a life led among the natives.

Dr. Farabee has carried out his survey work among the Central Caribs exceedingly well. One tribe, the Macusi, were studied in some detail, the information about them taking up some three-fifths (about 140 pp.) of the text, while the remaining twelve tribes are dealt with on some 100 pages. The material culture of the Macusi is described at some length, and this part of the contribution is naturally the most satisfactory. Under the heading of "Social Culture" we find such subjects as clothing and ornamentation; music, dances and games; magic, belief and mythology, while only one page is devoted to "political organisation," and a few pages to marriage, family and kinship, *i.e.* the really sociological themes. This is natural, for sociology can be studied only very inadequately in survey work. But every statement found in this book is clearly

formulated and well documented, and we are throughout inspired with full confidence that the writer has not gone beyond what well-founded evidence warranted him to say. This is the line of demarcation between worthless amateur gossip about "savages" which has been the bane of anthropology, and genuine scientific information, such as is given in the present volume.

B. M.

Cours de Physique a l'usage des élèves de l'enseignement supérieur et des ingénieurs. Par Prof. Jean Becquerel. Tome premier: Thermodynamique. Pp. ix + 430. (Paris: J. Hermann, 1924.) 25 francs.

THIS massive volume forms the first of a series of seven in which Prof. Becquerel proposes to deal with the various branches of physics. One cannot but feel awe as well as admiration at the boldness of such an undertaking, but if the remaining volumes reach the standard here set, the author must indeed receive our congratulations on a truly monumental work. Having faithfully accomplished the task of cutting the 430 pages of the present instalment, the reviewer would earnestly request the publishers to amend their methods by subjecting the remaining volumes to the guillotine.

The author believes that in the idea of energy and in the principles of mechanics may be found a guiding line which should never be abandoned. In the introduction he is careful to insist on the *experimental* basis of these principles, which are presented under an aspect compatible with recent progress in physics. Before beginning the exposition of thermodynamics, which has evidently been greatly influenced by the work of Planck and of Poincaré, the author discusses the discontinuous structure of matter and the kinetic theory of gases, acknowledging his indebtedness to the books of Eugène Bloch and of Jean Perrin. By the aid of the kinetic theory and the idea of the disordered movement of the molecules, the principle of Carnot is rendered less abstract. The statistical theory of thermodynamics, in which the author follows closely an exposition given by Langevin, gives precision to this idea.

As a descriptive treatise the book is an excellent one; the difficulties and mistakes of the student are carefully considered, but a British engineer would expect to find more attention paid to the numerical application of the theoretical results. H. S. A.

The Atmosphere and its Story: a Popular Presentation of the Science of Meteorology, free from Technicalities and Formulæ. By Ernest Frith. Pp. 204 + 9 plates. (London: The Epworth Press, 1924.) 6s. net.

IN his preface the author explains that this book is the outcome of daily explanations of the weather given to classes in meteorology at Clark University. The notes of these classes, collected and amplified, are here presented in book form.

The book is divided into four parts, one for each season of the year, the first section of Part I. giving a few brief notes on methods of observation of wind, temperature, humidity, rainfall, and snowfall. There follows a simple account of various physical processes in the atmosphere, supplying answers to many of the questions concerning the weather which strike the intelligent man in the street. The author writes in

the first place for Americans, and the details he discusses are the details of American meteorology. In spite of this, however, his book can be recommended to the general English reader as a useful introduction to weather phenomena. It is very well illustrated, the cloud pictures being in all cases selected from the U.S. Weather Bureau's new cloud chart.

The author discusses in an interesting and instructive manner the rôle of moisture in the air, and the formation of fog, cloud, and rain. The topics in each seasonal part are selected so as to appeal to the general reader, and discussed in such a clear manner as to instruct that reader in the physical processes which underlie weather. The author has succeeded in writing a book which should appeal to a very wide public.

Electric Cables, their Design, Manufacture and Use: a Series of Lectures delivered in the Moore School of Electrical Engineering of the University of Pennsylvania. By William A. Del Mar. Pp. vii + 208. (New York: McGraw-Hill Book Co., Inc., London: McGraw-Hill Publishing Co., Ltd., 1924.) 12s. 6d. net.

THIS treatise gives a good account, both historical and scientific, of cable manufacture. Wire was originally made by beating metal into plates, which were then cut into strips and rounded by hammering. It is stated that the art of drawing metal through dies was probably invented in the fourteenth century, although it did not come into practical use in Great Britain before the second half of the seventeenth century. The Birmingham Wire Gauge was the first attempt to standardise sizes. The first scientific attempt was made by Brown and Sharpe in America in 1855. The diameters of the wires they fixed form a regular geometrical progression from the English size of No. 36 (5 mils) to 4/0 (460 mils). As there are 40 sizes, the common ratio is the 39th root of 92, which is 1.123 nearly. This gauge is now officially called the "American Wire Gauge."

It is interesting to see that the formulæ first given in Fourier's "Théorie analytique de la chaleur" are in everyday use in cable work. Approximate values of the thermal conductivities of all the ordinary insulating materials used for cables are given, and the question of the grading of cables so as to enable them to resist puncturing by high voltages is discussed at length. There is, however, a great deal of work still to be done, both by the mathematician and the physicist, before definite conclusions as to the value of the method can be reached.

Crystals and the Fine-Structure of Matter. By Prof. Friedrich Rinne. Translated by Walter S. Stiles. Pp. ix + 195 + 15 plates. (London: Methuen and Co., Ltd., 1924.) 10s. 6d. net.

THIS translation has been made from the second edition of Prof. Rinne's book on fine-structure of matter, which he has named Leptology (λεπτός). According to the preface the book was written largely for the general reader, but discussion of a large number of aspects of the subject (there are fifteen chapters) has necessitated much condensation, and it is doubtful if much of the matter will be intelligible to the layman. This is noticeable in Chap. iii., "Crystallography and

Leptology," in which all the standard X-ray methods and the general morphology of crystals are outlined in thirty pages. The matter is very well selected and furnishes most stimulating reading; the book should prove most useful as an introduction to a detailed study of any aspect of crystallography. The later chapters, dealing with crystals and chemical reactions, are particularly suggestive.

The book is well illustrated, though there is, on occasion, insufficient reference to diagrams in the text. There are some excellent photographs of prominent crystallographers. There are constant references to the authors of fundamental researches; authors of other than German nationality receive perhaps rather less than their share of credit. A suggested addition is that references to original sources should be included for some of the more fundamental work; it is, for example, difficult to form a clear picture of the methods of Polanyi and Schiebold from the few sentences given them in the book.

Tudor Economic Documents: being Select Documents illustrating the Economic and Social History of Tudor England. Edited by R. H. Tawney and Eileen Power. (University of London Historical Series, No. 4.) In 3 vols. Vol. 1: Agriculture and Industry. Pp. xiii+383. Vol. 2: Commerce, Finance and the Poor Law. Pp. ix+369. Vol. 3: Pamphlets, Memoranda and Literary Extracts. Pp. viii+486 (London: Longmans, Green and Co., 1924.) 15s net each.

It is difficult to see how a better selection of material than this could well have been made. In three volumes the editors give us documents from every conceivable source, chronicles, pamphleteers, close rolls, court records, which illustrate every aspect of economic life in the changing epoch of Tudor England. They are not of interest to the economic historian alone; the student of literature and of social life will find much to interest him. The English itself is, often enough, of that stately texture which reached its highest point in the stiff splendour of Sir Thomas Browne; and ballads like "Nowe a Dayes," and Bastard's epigrams, are of the very heart of a great folk-thought. Special attention should be directed to the important, and hitherto unpublished, "Polices to reduce this Realme of England unto a Prosperous wealth and Estate," which is one of those minor discoveries as noteworthy to reader as to editor. It is a pity that the plan of the series did not permit of an ample introduction. One would have given much to know the editorial view of a period they have illuminated so wisely. H. J. L.

Electrical Drafting and Design. By Calvin C. Bishop. Pp. vii+165. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 10s. net.

THIS book is intended to bridge the gap between what a man learns in a technical college and what he is required to do in the office of an engineer, a contractor, or a power company. He should have had a two years' course in mechanical drawing, a knowledge of technical electricity including cables and machines. He must also know the Wiring Rules and have some practical knowledge of wiring. After giving instruction

about making practical drawings, special cases are considered, such as diagrams for three-phase panels, outdoor sub-stations, house wiring, etc.

The chapter on artificial illumination is very helpful. After defining the foot candle and the lumen a discussion of how the coefficient of utilisation and the depreciation factor affect the lumens required is given and formulæ are developed which enable these to be taken into account. The formulæ would not attract a mathematician, but as they take into account the dust and dirt which collect on the lamps, the ageing of the lamps as well as the coefficients of utilisation of the lumens by the various standard types of shades and reflectors which can be bought in shops, they are of practical value. Full descriptions are given of standard screws, bolts, copper rods, etc. We can recommend this book to the engineer.

La technique du vide. Par L. Dunoyer. (Recueil des Conférences-Rapports de Documentation sur la Physique. Vol. 7, 1^{re} Série, Conférences 17, 18. Édité par la Société Journal de Physique.) Pp. 225. (Paris: Les Presses universitaires de France, 1924.) 15 francs.

THE volume under notice forms an important contribution to the study of high vacua, and its publication emphasises the great improvements which have been effected in experimental methods during the past ten years. Chap. i. deals with various types of pumps, special attention being given to molecular pumps and to mercury vapour pumps. Chap. ii. is concerned with manometers. Some miscellaneous questions, such as the construction of connecting tubes, the elimination of occluded gas, and the analysis of residual gases, are discussed in Chap. iii.; and the last chapter deals with the production or improvement of a vacuum by means of absorbing materials or the electric discharge. The author rightly attaches great importance to the work of Martin Knudsen on the flow of gas rarefied to such a degree that the mean free path of the molecules has become large in comparison with the diameter of the tube.

Modern Practice in Mining. By Sir R. A. S. Redmayne. Vol. 1: Coal: its Occurrence, Value and Methods of Boring. Third edition. Pp. xvi+231. (London: Longmans, Green and Co., 1925.) 10s. 6d. net.

THIS constitutes a new edition, the third, of the first volume of a series intended to cover modern practice in coal mining, this particular volume describing the occurrence and properties of coal, the methods of searching for coal by means of boring and deep boring in general. The body of the work has not been greatly altered from the previous edition, but an additional chapter has been inserted in which some modern appliances and devices for determining the deviation of boreholes are described. The consequence of this method of dealing with the subject is that the body of the work remains somewhat out-of-date. For example, the bomb calorimeter is not even mentioned, though it is to-day the most generally used appliance for determining the calorific power of coal. Although not a matter of technical importance, a protest may well be entered against such an irritating piece of false Latinity as "apparati."

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Copepods in the Northern Hemisphere.

It has long been recognised that the distribution of freshwater copepods has been profoundly influenced by the incidence of the glacial period, since the lake-districts which they inhabit are to a large extent postglacial catchment basins. It so happens that there is a general correspondence between the three leading sub-orders and the three principal life-zones of lakes, namely, the creeping Harpacticoida of the littoral zone, the swimming Cyclopoida of the neritic zone, and the pelagic Calanoida of the open water. In the genus *Cyclops* there are upwards of twenty species common to the fauna of Norway (representing northern Europe) and of Germany (representing central Europe). Two significant differences are the absence of *C. capillatus* from Germany and the

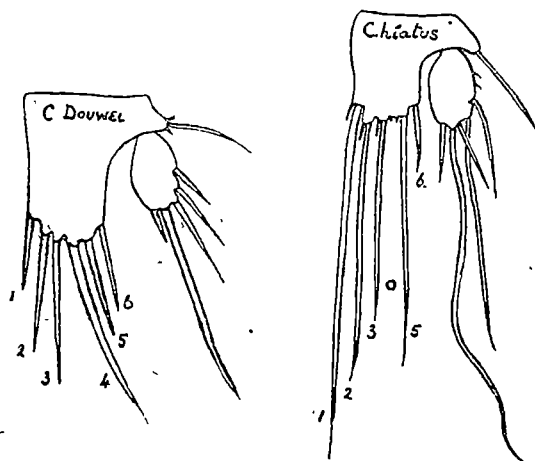


FIG. 1.—Fifth foot of female of *C. douwei* and *C. hiatus*.

absence of *C. prasinus* from Norway, both of these species occurring in Canada.

The parallelism between the harpacticoid copepods in Europe and North America is remarkable. The writer has contributed to this subject in recent years, last year making the canoe trip to the great lake Mistassini, which lies beyond the Laurentian watershed and drains into Hudson Bay by the Rupert river. The genus *Canthocamptus* is intimately bound up with the Holarctic region, but the species are local and eclectic and they have to be searched for far and wide in likely places. The uncultivated area that occupies much of the northern portion of Canada offers a profusion of such places, pools, swamps, springs and quaking bogs, which are by no means easy to reach, but the offerings of the more accessible lakes are such as to stimulate one to plunge into the wilderness in quest of these insignificant inhabitants of the primeval sources. The rule is that they differ alike from each other and from their transatlantic relatives by clean-cut unit characters and, incidentally, they are frequently monogamous, thus exhibiting the phenomenon of segregation in all its phases.

The American forms differ, sometimes in the least apparent respect, sometimes in greater degree, from

the European types, and this relation can be brought out by a tabular list, the knowledge of the items composing it being a secondary matter not necessary for the comprehension of the picture it presents. In two or three instances the differentiating characters are sufficiently intelligible to be mentioned. In *C. hoferi* the antennules are normal and 8-jointed, in its Canadian counterpart, *C. douwei*, they are 7-jointed. On the other hand, in *C. wierzejskii* the antennules are 7-jointed, and in the Canadian equivalent, *C. obotogamensis*, they are 8-jointed. Lastly, in *C. douwei* the fourth seta of the fifth foot is the longest of its set, in *C. hiatus* there is no fourth seta, and a gap, absolutely constant, is left for it (Fig. 1):

EUROPE.		NORTH AMERICA
<i>Canthocamptus staphylinus</i> Jurine	.	<i>staphylinoides</i> A. S. Pearse
" <i>minutus</i> Claus	.	<i>minnesotensis</i> C. L. Herrick
" <i>vejdoskyi</i> Mrazek	.	<i>minuscule</i> Willey
" <i>arcticus</i> Lilljeborg	.	<i>subarcticus</i> Willey
" <i>hoferi</i> Douwe	.	<i>douwei</i> n. sp.
" <i>fontinalis</i> Rehberg	.	<i>frigidus</i> Willey
" <i>northumbicus</i> Brady	.	<i>northumbicoides</i> Willey
" "	.	<i>hiatus</i> n. sp.
" <i>wierzejskii</i> Mrazek	.	<i>obotogamensis</i> n. sp.
<i>Wollersdorffia confluens</i> Schmeil	.	<i>Marshalli</i> albuquerqueensis Herrick
<i>Laophonte Mohammed</i> Blanchard and Richard	.	<i>L. calamorum</i> Willey

The above table does not exhaust the list of those that can be paired, and there are others which cannot be paired off. For example, *C. cuspidatus* Schmeil is represented here by an undescribed form (the new species named above are succinctly defined in this letter), while *C. illinoensis* Herrick has no European double, but appears in the ultramontane lakes and springs of Canada in a new form, *C. hyperboreus* Willey (Trans. Roy. Soc. Canada, 1925, in the press).

ARTHUR WILLEY.

McGill University, Montreal,
July 9.

The Effective Wave-length of γ Rays.

In his letter to NATURE (January 3, 1925, p. 13), Prof. Gray states: "If the secondary β -rays, produced in light elements by the hard γ -rays of radium-C, are recoil electrons, with energy given by the quantum theory of scattering, . . . the effective wave-length of the γ -rays must be much smaller than that usually accepted. Without going into details . . . no theory, as at present developed, can account for the properties of scattered γ -radiation."

By means of Wilson's cloud expansion method, I have observed the β -rays which are excited in gases by γ -rays hardened by 3 mm. of lead. It has thus been proved quite conclusively that these secondary electrons are recoil electrons, as predicted by Compton's quantum theory of scattering. These results, which Prof. Gray does not mention, permit me to draw some conclusions as to the effective wave-length of γ -rays.

I obtained photographs of β -ray tracks in a homogeneous magnetic field and calculated the velocities of different separate β -particles from the curvature of these tracks. The corresponding results may be found in *Zeitschr. f. Physik*, v. 28, p. 285, October 1924 (see NATURE, Dec. 6, p. 838).

If we assume that the effective wave-length of the γ -rays is equal to 0.02 Å U as usually accepted (that means $h\nu$ equal to about 600 kilovolts), then the maximum limiting velocity of the recoil electrons, according to Compton's theory, must be 400 kv. Now, I found that out of 72 electrons for which the velocity was measured, 69 had a velocity smaller than 400 kv. and only 3 electrons showed an energy surpassing this value (the swiftest of the latter had a velocity about 1000 kv.)

It seems to me that these results disprove Prof. Gray's statement. "If they are recoil electrons, the effective wave-length of the γ -rays must be taken as about $0.008 \text{ \AA.U.}$ in order that we may account, on the quantum theory of scattering, for their observed energy." (A wave-length of $0.008 \text{ \AA.U.}$ corresponds to a maximum energy of recoil equal to about 1300 kv.)

The main values of energy deduced from my data for electrons ejected at different angles to the primary ray also account for the usually accepted value ($0.02 \text{ \AA.U.}$) of the effective wave-length. I may add that this order of value is confirmed by new measurements of Amahd and Stoner (Proc. Roy. Soc. 106, 17, 1924), who found $0.019 \text{ \AA.U.}$ as the upper limit of effective wave-length.

It may be hoped that the direct counting of β -rays, and the measurement of their velocity, will give a distribution of intensity in the γ -ray spectrum which differs from that obtained by the usual method. By intensity is here meant the number of elementary quanta of γ -rays, and not, as is usual, their energy.

Ellis (Proc. Camb. Phil. Soc. 22, p. 374, 1924) obtained the γ -ray spectrum of radium-C, where the most intense line (in the above meaning) seems to correspond to a wave-length of $0.02 \text{ \AA.U.}$ A strong line E_{34} , lying near the limits of the spectrum ($\lambda = 0.00867 \text{ \AA.U.}$), is twice less intense, and, according to Compton's theory, much less effective as to the production of recoil electrons.

-As to my disagreement with Prof. Gray, I may state the following. The method used by me has the advantage of making it possible to observe the undisturbed spectrum of secondary β -rays, which are produced directly in the gas. In the case of a screen being the source of secondary β -rays, the distribution of velocities will be altered owing to the absorption of the rays in the screen itself; if we want to observe an undisturbed spectrum by the usual method, we ought to have β -rays excited in very thin layers of matter, which may be impossible so far as light elements are concerned.

On my photographs there may be seen not only the tracks of the β -rays produced in the gas, but also the tracks of those rays which take their origin in the 2 mm. thick wall of the chamber; in this case, we observe the secondary corpuscular radiation of the wall which is "hardened" by the wall itself, and the photographs show the presence of a comparatively larger number of swift electrons (most of these photographs show tracks of particles the velocities of which approach 1000 kv.).

D. SKOBELTZYN.

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June 29.

Further Spectra associated with Carbon.

DR. R. C. JOHNSON, in an article with the above title which has just appeared (Proc. Roy. Soc., A, 108, 343, June 1925) has given in his Table IV. a set of six new double-double headed bands, degraded to the violet, and associated with the comet-tail spectrum, which is also double-double headed, but degrades to the red. I find that these new bands have the same set of initial vibration states as the first negative group of carbon, and this, in connexion with the relation stated in my letter of June 8 to NATURE, published in the issue of August 1, that the set of final states of the first negative group and of the comet-tail bands is the same, leads to relations of considerable importance in the quantum theory of band spectra.

In the first place, the final states of the new bands

must be identical with the initial of the comet-tail bands. This is in fact the case, using the assignment of vibrational quantum numbers given in the letter just quoted. This proves the correctness of that assignment and shows that the weak $\lambda 5281$ band omitted in that assignment, as well as the weak $\lambda 5764$ and $\lambda 6354$ bands, are not a part of the regular group. The values of the vibrational quantum numbers $n'-n''$, for Johnson's six bands, in the order listed by him, are $0-1$, $1-2$, $0-0$, $1-0$, $2-0$, $3-0$. Secondly, the frequency of the "origin" of the new Johnson group must equal the difference in frequency of the origins of the other two groups. This also is accurately true, provided one uses Baldet's (*Comptes rendus*, 180, 820, 1925) series interpretation of the comet-tail bands, and Blackburn's (Proc. Nat. Acad. Sci., 11, 28, 1925) of the first negative group.

More generally, from measurements of the frequencies of the individual lines of the comet-tail and first negative group bands, one can calculate immediately the frequency of every line of every band of the new group, provided the structure of the bands of the various groups has been properly interpreted, in working out the systems of energy levels. It is this last fact which makes the above relations of such importance, for there is at the present time a sharp difference of opinion concerning the interpretation of a number of vital points in connexion with the series structure of complex bands such as these. A fine structure analysis of Johnson's new bands should allow a definite decision on a number of these points.

Without any further data, however, it is possible to decide definitely that the comet-tail bands have a double electronic level in the initial state, of spacing $\Delta\nu = 126$. Each of these bands has a double "origin", given by the heads of the two Q branches, according to Baldet's (*loc. cit.*) analysis, thus confirming this analysis in contradiction to Blackburn's (*Phys. Rev.*, 25, 888, 1925) quite different interpretation. Similarly the new bands each have a double origin with the same spacing ($\Delta\nu = 126$). This double origin is the second and fourth "head," counting from the red, while in the comet-tail bands it is necessarily the second and fourth head, counting from the violet. As might be expected, the theoretically inconsequential spacing of the first and second heads, second and third, etc., in each band is not at all the same for the two groups, but the spacing of these two Q branch heads ("origins") is precisely the same.

Other points at issue relate to the application of the combination principle to the rotational energy levels, the question of one-half versus one-quarter values of electronic momentum, the numerical magnitude of the moment of inertia, etc. They cannot be discussed in a brief communication like this, but Dr. R. S. Mulliken, in an article just sent to the Proc. Nat. Acad. Sci., mentions some of the difficulties of interpretation in the case of these particular band groups.

RAYMOND T. BIRGE.

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On the Theory of the Zeeman Effect.

IN his letter to NATURE of June 27, p. 978, Prof. W. M. Hicks points out that the theory of the Zeeman effect on the application of Larmor's theorem is no explanation, and concludes that the theory of the Zeeman effect on the quantum basis yet remains to be given.

I may say that the classical theory can still demonstrate the Zeeman and Stark effects. In the Proceedings of the Pont. Academy of Sciences (March 1923) I

proposed a theory for both effects as a problem of perturbation in electron orbits, and last August I presented the same at the International Mathematical Congress at Toronto

In the simplest case of circular orbits due to a central force (Coulomb's force) represented by the equations in polar co-ordinates

$$\frac{d^2r}{dt^2} - r\left(\frac{d\theta}{dt}\right)^2 = -\frac{\mu}{r^2}; \quad \frac{1}{r} \frac{d}{dt} \left(r^2 \frac{d\theta}{dt} \right) = 0$$

we can introduce a perturbing force X due to a magnetic or an electrical field, and determine the variations produced in the characteristic quantities. For the primitive (non-perturbed) radius of the circular orbit, the X force introduces a correction ρ given by the equation

$$d^2\rho/dt^2 + n^2\rho = 3X \cos nt,$$

n being the average time of astronomers. We can integrate the equation in every hypothesis and deduce the variation of the periodic time n . Let X be the effect of a magnetic field H , then ρ results, $\rho = \pm evH/mcn^2$, e , v , m , c being well-known quantities, and the primitive periodic time becomes $n = n_0 \pm 3eH/2mc$, containing the explanation of simple Zeeman triplet

If we assume the central force to be an elastic force, the solution becomes $n = n_0 \pm eH/2mc$, the well-known Lorentz's formula

The more complex Zeeman effects may be deduced from elliptical orbits, and the solution gives also a displacement of perihelion in terms of classical methods

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Science and Intellectual Freedom.

MR. WELLS's letter in NATURE of July 25, p. 134, fails to notice a most important distinction. Knowledge concerning the origin of species may be, and usually is, honestly and honourably desired for its own sake without any view of practical application. Knowledge concerning contraception is sought, either from mere prurience, or from intention to practise it or to teach others to do so. Many who hold that the State has no right to control its members' thoughts hold that it has the right to control their actions, and such persons, if they hold (as I do not) that the prevention of conception is wrong, may oppose the propagation of knowledge which has no value except in so far as it leads to such prevention, without being insincere in their desire for intellectual freedom.

There are, of course, doctrines, especially in ethical, political and economic theory, the intellectual and practical values of which are so closely associated that it is difficult to decide into which class they fall. But the solution of the problems raised by these borderline cases—which are those that cause real difficulty—is not aided by a refusal to recognise that they are borderline cases, and that the classes which they separate are generally distinct and present no difficulty whatever to a judicial mind.

NORMAN R. CAMPBELL.

The Isotopes of Mercury.

THANKS to generous financial assistance, for which I am indebted to the Department of Scientific and Industrial Research, I have been enabled to build a mass-spectrograph giving double the dispersion of the one previously in use. The final adjustments of

this instrument are by no means complete, but it has already given results of great promise.

Preliminary photographs of the mass-spectra of mercury show its lines clearly resolved and so enable a definite statement to be made on the mass numbers of its most important constituents. These are six: 198 (4), 199 (5), 200 (7), 201 (3), 202 (10), 204 (2). The numbers in brackets indicate very roughly the relative intensity of the lines and, if we assume the whole number rule to be exact, correspond to an atomic weight in agreement with the accepted chemical one, 200.60. The possibility already suggested (*Phil. Mag.*, 49, p. 1196, 1925) that the mercury group might show a resemblance to that of cadmium is therefore borne out to some extent, although the extreme variation in the intensity of its lines appears rather less than in that element. On several of the mass-spectra obtained there are faint indications of other lines, but a great deal more work will have to be done before these are proved to be due to isotopes of mercury or not, in any case their proportions are comparatively insignificant.

These results have a direct bearing on the claims recently made that under special conditions mercury has been transmuted into gold by the addition of an electron to the nucleus. It is clear that if the gold were so formed it would have an atomic weight at least as high as 198, that is, perceptibly higher than that of ordinary gold, 197.2. A definite determination on this point would seem to provide conclusive evidence on this interesting problem.

F. W. ASTON

Cavendish Laboratory, Cambridge,
August 1

Separation of the Depressor Principle from Hepatic Tissue.

THE action of water-soluble substances prepared from hepatic tissue in lowering the blood pressure of normal animals has been noted in the literature for many years. Investigations as to the chemical nature of this principle, which were initiated in this laboratory and the Department of Physiology eighteen months ago by Drs. James and Laughton, have yielded the following results.

The active principle is non-protein in character and is found in the abiuret fraction. It is soluble in water-alcohol solutions up to 80 per cent strength. It is precipitated from aqueous solution by phosphotungstic acid along with the diamino acid fraction, and the material recovered in aqueous solution can be further purified by extraction with ether, which has the capacity for dissolving out a very active principle which depresses the arterial tension and maintains it at a subnormal level for a long period.

The depressor substance is associated with a pressor principle in the abiuret fraction. These two are separated during the treatment with phosphotungstic acid, since practically all the pressor element remains in solution.

Not only is the normal pressure reduced to subnormal levels but also artificial hypertension, induced by various well-known pressor substances, is similarly reduced to any desired level depending on the dose employed.

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The Problem of Stellar Evolution.

By Prof. H. N. RUSSELL, Princeton University Observatory.

THE great problem of the evolution of the stars may be attacked along two main lines. We may study the properties of the stars themselves, as revealed by observation, and find orderly sequences among them; or we may analyse, on general physical principles, the constitution of a mass of gravitating matter, and the probable sequence of its changes.

Advances on these two fronts have shown a certain tendency to alternation. Lockyer's conception of stars of rising and falling temperature was based mainly on general physical considerations. The recognition of the sequences of giant and dwarf stars lent strong support to this theory, and—as the present writer showed some eleven years ago—a great mass of observed details fits in with remarkable completeness with the idea that the stars rise in temperature until the gas in their interior becomes compressible only with difficulty, and then cool down again.

More recently, progress has been mainly on the theoretical side, and has been very rapid. Among the milestones on the way may be noted the application of the theory of radiative equilibrium to the internal constitution of the stars, the appreciation of the fundamental importance of radiation pressure in this equilibrium, and of ionisation in making the mean molecular weight low and almost independent of chemical composition—then, recently, the development of rational, rather than empirical, expressions for the elusive opacity-constant, and the recognition that the dismembered atoms inside the stars are so small that even at enormous densities the material must behave like a perfect gas. Several investigators—Jeans, Kramers, Eggert—have contributed to this field, but much the largest share is Eddington's.

Meanwhile, observation has established conclusive evidence—with the joint help of astronomy, physics, chemistry, geology, and biology—that the life of the sun must be enormously long, and that the stars must have within themselves some vast store of potential energy, of hitherto unimagined extent.

These new developments must obviously lead to changes in the theory of stellar evolution to which reference was made above. One frank, but not unfriendly, critic recently characterised these changes as "sudden death." The writer—remembering Mark Twain's response to the rumour of his own demise—believes that in this case, too, the reports have been "greatly exaggerated."

On one point there can be no possible doubt. The feature of the older theory which assumed a fall of internal temperature in the denser dwarf stars owing to the close-packing of the atoms, must be finally abandoned. Eddington's argument is conclusive, and it is clear that the low surface temperatures of these stars must be ascribed, not to low internal temperatures, but to the increase of opacity with density, which prevents the heat from leaking out quickly to the surface.

The theory of the internal constitution and the luminosity of the stars is now really in a fairly satisfactory state. The relations connecting the mean molecular weight and the opacity-constant with the

temperature and density appear to be well enough known to assure us that the approximations used by Eddington and Jeans must be close to the truth. Only one quantity remains uncertain— η , which represents the ratio of the average rate of generation of heat per gram in the portion of the star within a given distance of the centre to the corresponding quantity for the whole star—and Eddington has just shown that great changes in the law of its increase toward the centre affect the surface characteristics of the star but little.

Though approximations must be made in the solution of the equations, and opinions differ as to which is best, the main results are clear. The luminosity of a star (its total radiation) increases rapidly with increasing mass, but changes relatively little with the surface temperature, so that the influence of the latter may be expressed by a subsidiary correction—which rarely, if ever, reaches one magnitude, if the solar type is taken as standard.

The new theory, therefore, indicates that a star of given mass must be not far from a definite absolute magnitude, but may have any radius, surface temperature, and spectral type (the old restriction to densities less than a certain limit being unfounded).

The first of these conclusions is strikingly confirmed by observation, both for the most accurate individual data and for averages covering all the available material.

The second, however, is in definite disagreement with the facts. The stars of a given mass—or a given absolute magnitude, which are far easier to pick out, and afford an equally good test of the theory—are by no means indiscriminately distributed among the various spectral classes.

Among the brightest stars, it is true, all spectra are found; but among stars of not more than ten times the sun's luminosity, a large majority of those of given brightness are found within narrow spectral limits. Observational selection is much less disturbing if the grouping is made in this way, and there can be no doubt of the reality of the phenomenon.

From this viewpoint the stars may be divided into three groups:

1. The main sequence (a name suggested by Prof. Eddington), for which the luminosity diminishes rapidly, with increasing redness. This sequence includes most of the O, B, and A stars and all the ordinary dwarfs, and represents the most pronounced axis of concentration of the points upon the familiar diagram in which absolute magnitude is plotted against spectral type.

2. The giants—lying on the bright side of the main sequence, with representative points widely scattered, but showing a fairly definite axis of concentration, joining the main sequence near class F, and running somewhat upward for the redder stars.

3. The white dwarfs, of low luminosity and high surface temperature. Few such stars are yet known, but there are three of them within six parsecs, and they must be more abundant per unit volume of space than any other class except the K and M dwarfs.

Fig. 1 shows the relations for twenty typical stars (taken mainly from Eddington's list). Nos. 6 to 18 clearly indicate the main sequence. Nos. 1 to 5 give a sketchy idea of the giants, and 19 and 20 are the most notable white dwarfs.

To account for this distribution, something more than the internal equilibrium of the stars must be considered. The problem is intimately bound up with that of the source of stellar energy, and the probable secular diminution of stellar mass.

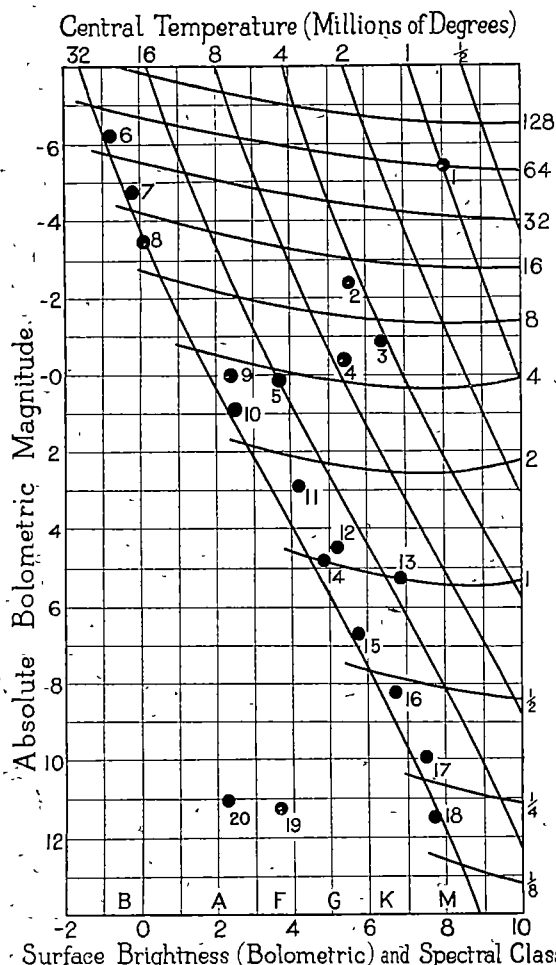


FIG. 1.—1, Antares; 2, δ Cephei; 3, Arcturus; 4, Capella A; 5, Capella B; 6, Plaskett's star; 7, V Puppis; 8, V Cygni; 9, β Aurigæ; 10, Sirius A; 11, Procyon; 12, α Centauri A; 13, α Centauri B; 14, sun; 15, ξ Bootis A; 16, ξ Bootis B; 17, Kruger 60 A; 18, Kruger 60 B; 19, Sirius B; 20, O₂ Eridani B.

All commentators agree that if the mass of a star remains nearly constant throughout its history, no comprehensive scheme of evolution appears to be possible. But, if the major part of the mass can ultimately be transformed into energy and radiated away, the problem becomes more hopeful.

The first question to be considered is whether the rate of transformation of matter and generation of heat within a star is independent of the temperature and pressure, or not. If the former is true, the star must expand or contract until the rate of loss of heat from the surface balances the unalterable income; if the latter, until the rate of production balances the loss.

An accumulation of heat inside a gaseous star compels its expansion. Unless this is accompanied by an increase of the loss of heat from the surface, a star of which the internal income of heat is fixed cannot be in stable equilibrium. Even if the outgo balanced the income at the start, the slightest deviation would go on increasing, until the star either expanded indefinitely or contracted to minute size. Now recent theory indicates that it is very probable that increase in diameter, and fall of surface temperature, go with decrease in total radiation. Hence, as Eddington points out, the theory that the rate of generation of heat is independent of the internal conditions appears to be untenable.

If this rate varies with the temperature (or perhaps with the density) it is practically certain that it must increase rapidly as the temperature rises—for there is certainly no considerable generation of heat inside the earth. In this case the expansion of the star lowers the internal temperature, and cuts off the excess supply of heat; and the adjustment to such a condition that just enough heat is generated to supply the leakage to the surface will be automatic and stable.

It appears, therefore, necessary to conclude that the rate of transformation of matter into energy increases with the temperature. The thermodynamic difficulties in the way of this hypothesis are serious, but probably not insuperable.

Here, however, we can no longer call our present knowledge of the general properties of matter to aid in solving the specific problem; rather we must once more be guided by the observed astrophysical data.

The two sets of curves in Fig. 1 are computed from Eddington's theory (Monthly Notices, R.A.S., 84, 104, and 308, 1924) (taking fuller account of the probable change of molecular weight) and represent stars of fixed mass or fixed central temperature.

It is at once obvious that all the stars of the main sequence have very nearly the same central temperature—about thirty million degrees. A theory based on different approximations might not make these temperatures come out so remarkably alike, but would still leave them very similar. The giants are cooler inside, and the white dwarfs must be hotter, though numerical calculations are unsafe for such great densities.

The concentration of stars along the main sequence can now be simply explained by assuming that, in the neighbourhood of a temperature of about thirty million degrees, the rate of transmutation of matter into energy increases very rapidly. A higher central temperature than this would generate heat faster than it could escape, the star would expand and cool, and, practically, it could not pass this limit. One would expect the internal temperature to be somewhat higher for the stars of great luminosity (which radiate more heat per gram). An entirely permissible change in the constants of the theory would allow this.

If all the matter in the stars behaved in this way we should expect a star to pass through the giant stages precipitately, since the generation of heat at lower internal temperatures would not suffice for equilibrium. This is evidently not the case, so that it is necessary to postulate that there are also one or more forms of matter which are transformed at lower temperatures,

and supply the "fuel" for the giants. Some highly refractory constituent seems to be indicated by the white dwarfs.

The first stage of a star's history which can be clearly visualised is, then, a sphere of very rarefied gas, comparable in diameter to the orbit of Uranus or Neptune, and with a central temperature of a few hundred thousand degrees. Losing heat by radiation, it contracts, at first very rapidly, drawing upon its gravitational energy. When the central temperature reaches some critical value—probably rather less than a million degrees—the degradation of some form of matter (either wholly into energy or into some less massive form, with corresponding energy-emission) begins, and a star is born. The rate of evolution now depends on that of the exhaustion of the transformable material, and, as this is used up at the centre, the star must slowly contract so that the temperature rises, and new regions, nearer the surface, become the main seat of the transformation.

If, as von Zeipel believes, and Jeans doubts, there is active mixing by radial convection, the region of transformation will be less localised, but the general result the same—the temperature rising, as the quantity of exhaustible material diminishes, in order to keep up the rate of liberation of heat. Several successive processes of this sort, involving the transformation of various kinds of matter with different critical temperatures, may be operative during the giant stage.

We must next suppose that as a temperature of some thirty million degrees is approached, a process comes into play which leads to the actual annihilation of the main mass of the stellar material, with a correspondingly great liberation of energy. The central temperature will then remain nearly constant, and the star steadily decrease in mass, "burning itself away" at the hot centre, gradually growing dense and more opaque, and passing down the main sequence.

Finally, to account for the white dwarfs, we must believe that there exists a certain residue of refractory material, immune to transformation at thirty million degrees. As the main constituents become exhausted this will preponderate, and at last be almost exclusively present. If this residue were incapable of transformation, rapid gravitational contraction would ensue until even the ionised atoms were jammed close together. The considerable abundance of the white dwarfs per unit of volume suggests, however, that further energy-liberating changes occur and delay the last act.

The course of evolution would then be represented, on the familiar diagram, not by a reversed figure 7, but rather by a reversed letter Z. During the giant stage the surface temperature rises, and the representative point moves to the left. Then along the main sequence it falls, and the point moves downward and to the right. Finally, the star becomes a white dwarf, the temperature rises, and the point moves to the right again.

Whether the lines representing the giant and the white dwarf stages run nearly horizontally, or downward to the right, depends upon the loss of mass in these stages—that is, upon the quantity of matter available for transformation within the corresponding ranges of temperature. The large number of the giants suggests that a considerable fraction of a star's mass is lost during

these stages, and that the evolutionary line slopes downward.

If the easily transformable material becomes nearly exhausted before the main transformation sets in, there will be a period of relatively rapid change between the redder giants and the main sequence, and such intermediate stars will be statistically infrequent, as appears to be actually the case.

Too few white dwarfs are known to justify a similar discussion.

It should be especially noticed that while, on the theory here proposed, all stars should pass along at least a part of the main sequence, they may be very different in the other stages. A star of great initial mass would give an evolutionary line crossing the diagram near its top, and joining the main sequence at class B or class A. One of small mass might come in at F or G, or even lower. The existence of such stars, intermediate between the redder giants and dwarfs, is therefore no argument against the theory either in its present form, or for that matter, in the older and abandoned one.

The fainter component of α -Centauri—as Fig. 1 shows—seems to be a star of this sort, and, from the present viewpoint, would be classed as a giant of small mass (as must also be the large red companions of such eclipsing variables as U Cephei).

Similarly, the level at which a star would break away from the main sequence, and become a white dwarf, would depend on the quantity of "refractory" matter originally present (or perhaps formed as a by-product of other transformations), and any combination of absolute magnitude and spectral type is possible.

This scheme of stellar evolution is very similar to its predecessor. The only important point of difference is (as Eddington puts it) "that the diminishing brightness in the dwarf series is due to decreasing mass, and not to a falling off in compressibility." On the other hand, the difference of mass between giants and dwarfs is now explained, and the white dwarfs—formerly most puzzling—now, thanks to Eddington, find an orderly place at the end of the sequence.

The notion of the transmutation of mass into energy, upon which the new theory is founded, appears to rest upon strong evidence. The specific types of transformation postulated above are frankly adopted *ad hoc*, as indicated by the observed statistical facts; but while the subject is still outside the range of existing theories of the constitution of matter there is nothing else to do; and so far as can be judged, the postulates seem plausible enough.

The youngest known stars (not in years, but in evolution) appear to be those of class N and Me and it is probably no accident that practically all of these are variables. The latest known stage, judging by the density, is found in the companion of Sirius. This is abnormally faint for its mass, and it may be, as Eddington suggests, that close-packing of the atoms is beginning to have an influence here (at a central density of the order of one ton per c.c.!).

The final stage is still uncertain. Either the loss of mass continues indefinitely until the star practically disappears, or else close-packing halts the rise of temperature, before the most refractory atoms can be

is one that would give rise by differentiation to the series of alkali-rocks. These are characterised by low proportions of iron, lime, and magnesia, and an excess of potash, soda, and frequently alumina. In normal rocks the alkalis and lime of the feldspars are accompanied by an equal molecular amount of alumina. The magnesia, the iron-oxides, and the remainder of the lime are also usually associated in many monoclinic pyroxenes and amphiboles with alumina. If a considerable proportion of the magnesia, iron-oxides, and lime be removed in the form of garnets, less than one-third of the equivalent proportion of alumina will go with them, so that it is not surprising that the percentage of alumina in the residue should be high, especially if, as appears frequently to happen, little or no zoisite or epidote is formed. In some instances, however, a certain number of the garnets formed at great depths are carried up with the alkaline magma.

The alkali rocks are sometimes found alone, as in the neighbourhood of Montreal and many localities on both sides of the Atlantic; but frequently they occur as occasional exceptions in a vast upflow and outpouring of normal rocks, mainly, but not exclusively, of basic composition. Examples of such modes of occurrence are met with in the Tertiary igneous rocks of the British Isles. Other examples of this association of normal and alkali-rocks occur in Scandinavia, India, and Australia.

Beyond the Eastern Atlantic deeps to which reference has been made lies the Central Atlantic bank, rising some 6500 feet (2000 metres) above the ocean-floor on either side of it. It only shows at the surface by virtue of local eruptions of volcanic rocks, mostly basic, but including occasional alkali-rocks, such as those of Rockall, which, however, is surrounded by a basaltic plateau close below the surface of the sea. The mass of the ridge must, however, consist of acid or sedimentary rocks, such as compose the continental masses. If it were not made up of such lighter rocks, it would not continue to exist. Whenever eruptions or earth-movements may, for the time being, disturb the isostatic equilibrium in any area, the forces of gravity acting on the yielding rocks of the earth's crust tend to restore it. Whatever may be the inequalities of the depth of the sea, they are compensated by the variation in the density of its bed. The only exceptions are minor irregularities so small that they can be maintained by the strength of the rocks, or so recent that the slow forces of readjustment have not had time to operate.

West of the central ridge is another ocean-deep formed in all probability by the same process of rifting, in the course of which the eastern margin of the North American continent drifted away to the westward. These Atlantic rifts represent far greater relative horizontal movements than those affecting western Europe, but they seem to be essentially similar in nature. The total displacement, towards the west, of eastern America relatively to western Europe would appear to vary from about 3000 miles (5000 km.) in the south of the North Atlantic to about 1400 miles (2300 km.) in the north. As Wegener claimed to be the case, the movement seems to have been largely in the nature of a rotation about a point in the far north. He thought, however, that the east of North America and

the west of Europe were once actually in contact; whereas, according to my view, they were still separated in later Palæozoic times by an area, much narrower than the present Atlantic, which was sometimes wholly terrestrial and sometimes partly occupied by shallow mediterranean seas with a roughly north-and-south trend, one on the east and one on the west. They seem to have been to a great extent independent, for the marine faunas preserved in the later Palæozoic rocks of western Europe are strikingly different from the contemporary marine faunas in eastern North America, indicating the probable existence of a land-barrier between them. When, on the other hand, marine conditions were replaced by terrestrial, the similarity of the fossils and of the climatic evidences would seem to prove the existence of a continuous land-area.

When the rifting occurred, the rocks of the central land must have been fissured like those of Devon and Cornwall, and slipped away partly on one side and partly on the other, so that they no longer appeared above the sea, nor was the isostatic adjustment sufficient to raise them to the surface. The volcanic accumulations which form islands at various points on the central bank show a local excess of gravity. This indicates that their elevation is comparatively recent, so that isostatic adjustment is not yet complete. When it is, they may be wholly submerged; an event which would be hastened by subaerial and marine erosion.

A similar succession of events appears to have taken place in the South Atlantic. There the remarkable resemblance between the rocks on the opposite shores—ranging from the Devonian to the Jurassic—both in lithological characters and in fossil contents, seems to lead almost inevitably to the conclusion that they were once in much closer proximity, though probably not in actual contact, as supposed by Wegener, for there, too, is an important mid-oceanic ridge from which volcanic islands rise to the surface.

Much of the structure of the African continent has yet to be determined; but, so far as it is known, it appears everywhere to support the view that there is evidence of the prevalence of tension directed outwards from the centre. This is in accordance with Wegener's contention that at the beginning of Mesozoic times there was a great "Ur-Kontinent," of which Africa was the centre, and that it has since been broken up by a relative movement of South America to the west, of west Antarctica to the south-west, of India to the north-east, of Australia to the east, and east Antarctica to the south-east.

Dr. R. Staub,¹² however, contends that, like India, Africa itself has moved northwards and given rise to the Eocene (Alpine) folding of Europe.

The question of the origin of regions of tension must now be considered. Why should they exist, or, to go one step further back, why should different portions of the continental masses tend to move apart from each other?

On the whole, the movement and the corresponding tension are roughly east and west, though frequently more or less diverted by local circumstances. This prevalent direction naturally suggests that it is in some

¹² "Der Bau der Alpen," Berne, 1924, pp. 7-8

way determined by the rotation of the earth, and is a result of tidal retarding action. Now, the rate of the retardation of the earth's rotation is known from astronomical evidence to be approximately an increase of 9 seconds in a century, per century,¹³ and there seems reason to believe that this may all be accounted for by the friction of tidal currents in shallow seas (that in the oceans being negligible), so that it is apparently unnecessary to call in friction produced by the tides in the solid substance of the earth. It is claimed too that these tidal movements are so small—of the order of 1 metre, or 10^{-7} of the earth's linear dimensions—that the earth must be considered for this purpose as perfectly elastic, and that any purely elastic distortion of the earth can have no retarding effect.¹⁴

The first objection ignores the fact that, if there is a tidal deceleration, there is also an acceleration due to the secular contraction of the earth, which must, as I hope to show on another occasion, be considerable. Even the decrease in the ellipticity of the earth, itself due to a decrease in the velocity of its rotation, involves an acceleration which prevents that decrease from being so great as it otherwise would be. The retardation of the earth's rotation is therefore the difference between a decelerating and an accelerating effect, and these may be and probably are much greater than the difference between them. In other words, the deceleration, which is the measure of the effect of tidal friction on the earth, is equal to the retardation deduced from astronomical observations *plus* the acceleration due to the earth's contraction and change of form. Indeed it is possible that at an earlier period the acceleration may have been greater than the deceleration.

With regard to the second objection, I have recently shown¹⁵ that the tidal distortion in the more superficial zones of the earth is much greater than in those at greater depths, and it would appear that in the former the ratio of the distortion to the total thickness of the zones would be of the order of 5×10^{-6} , fifty times as much as for the whole earth. Therefore the internal friction (the hysteresis, so to speak) in elastic distortion may not be negligible—especially as the outer crust is far from homogeneous, being subject to numerous forms of discontinuity, such as, on a small scale, the boundaries of crystals, sand-grains, pebbles, and fragments, besides planes of weakness in the crystals themselves, and, on a large scale, stratification, lamellation, foliation, cleavage, joints, faults, unconformities, and intrusions. Everywhere there are occasions of imperfection and inequality in mutual mechanical reactions, so that elastic distortion must frequently give rise to movements between surfaces in contact, with resulting friction and absorption of energy. In many cases forces tending to produce such a result are already acting, and only require a slight addition in order to overcome the resistance opposed to them.

¹³ That is to say, the length of a day now is $9/(100 \times 365)$ of a second more than it was a century ago. It is usually assumed that this retardation affects the entire mass of the earth, whereas it is probable that the retardation of the earth's upper zones is slightly greater than that of the interior. If this be so, a correspondingly less amount of friction will be required to produce the observed result.

¹⁴ H. Jeffreys, "The Earth," 1924, chap. iv. The effect of "elastic viscosity" (which involves permanent set or flow) is excluded where the periods of distortions are as short as those of the tides, for it is known to be inoperative with the Euler nutation, the period of which is considerably longer—fourteen months.

¹⁵ *NATURE*, vol. 114 (1924), p. 749.

There seems, therefore, every reason to suppose that there are, even apart from the friction in shallow seas, forces tending to retard the rotation of the earth and especially of the outer zones, consisting mainly of crystallised igneous rocks and sediments, and thus to produce a movement of the exterior relatively to the interior from east to west.

These considerations unfortunately leave unexplained the divergent relative movement from Africa of the other constituent parts of the "Ur-Kontinent"—why the Antarctic continent should have drifted to the south or (alternatively) Africa to the north, or why America should have been retarded by tidal friction more than Europe-Africa, and Africa more than India and Australia.

There are, however, other possibilities that may explain the relative movement of portions of the earth's crust. According to Wegener, the sial, which in primeval times had covered the *simā* over the whole earth, had in the late Palæozoic era been restricted, so as to extend over little more than the fourth part, but it had become at the same time correspondingly thicker, as a result of the extensive folding that it had suffered. It then, as already stated, occupied a single area, of which what we now know as Africa was the centre, although there is evidence that some portions were covered by shallow seas, just as the present Mediterranean Sea now covers a part of the Old World continental area.

We have seen that since Hercynian times it has split up, different portions moving away in different directions. The evidence adduced by Wegener renders this at least a plausible hypothesis. He ascribes these changes to different rates of westward movement, and a drift away from the Poles; but a general drift from the centre of Africa to the centre of the Pacific seems to represent the real character of the movement more happily. Prof. H. Darwin explained such a movement by the hypothesis that the moon was, more than 50,000,000 years ago, thrown off from what is now the Pacific, and took with it much of the lighter surface-rocks, the sial in fact, which then occupied that part of the earth, and that the remainder has since been drifting towards the region of high density thus caused. If so, it would seem to have been held back by the resistance of the floor of the Pacific, and this has given rise to the circle of folded mountains which surrounds that ocean. Dr. H. Jeffreys,¹⁶ however, believes that the earth gave birth to the moon when the young mother had herself only existed some 10,000 years, and that this must have occurred more than 1,000,000,000 years ago. He gives reasons for believing that the earth was then almost fluid, with at most a thin solid crust on the outside. This, in the violent agitation that took place during the process, must have been broken into fragments which would have forthwith spread themselves out in such a way as to become roughly distributed over the earth.¹⁷ In any case, it would be inconceivable that the drifting towards the centre of the Pacific should have been delayed until nearly the end of the Palæozoic era. Of course, if the birth of the moon could have taken place in late Palæozoic times, when the earth's crust was already consolidated, and if it could have occurred, while

¹⁶ "The Earth" (1924), chap. iii, p. 77.

¹⁷ *Ibid.* p. 140, J. H. Jeans, *Proc. Roy. Soc.*, vol. 93, A (1917), pp. 413-17.

allowing life to go on much as usual in other parts of the globe, there is no reason why the drift should not have taken place in Mesozoic and Kainozoic times; but, according to Jeffreys, the want of fluidity in the upper zones of the earth would then have rendered the separation impossible. Another objection to such an hypothesis is that there have been, during Palæozoic times and the long ages of the pre-Cambrian era, repeated occurrences on a large scale of mountain-building, folding, thrust- and slip-faults, and igneous intrusions and extrusions; so that there must have been repeated previous transformations similar to those that we can trace with greater distinctness in the immediate past. We cannot explain each of these by the birth of a satellite, for there is only one now existing.

There seems, however, to be a simpler hypothesis, which I will briefly indicate. The earth, as we know, contains a dense core surrounded by lighter material, the upper portion of which constitutes the sima. The sial is of course of comparatively insignificant thickness. It has been contended¹⁶ that in the early history of the earth, when the resistance to compression and the rigidity were less, the heavy core was, on account of the earth's rotation, in a state of unstable equilibrium, and that, as a result, its centre of gravity probably does not now exactly coincide with that of the earth as a whole. Consequently, at that point on the equator to which the core is nearest gravitation is at a maximum. As, however, the attraction of the moon and sun results in friction which tends to retard the rotation of the earth's higher layers more than the interior, the former must have a slow movement relatively to the latter. We have seen that there is reason to suppose that in Palæozoic times the continental masses of sial were more or less con-

centrated round what is now Africa, forming the "Ur-Kontinent" of Wegener. This may well have been due to the fact that the maximum of gravity was then situated in that part of the earth. If then, during Mesozoic times, the movement of the higher layers of the earth had brought the centre of the Pacific into the position of maximum gravitation, the former great Palæozoic continent would tend to break up and drift apart towards the Pacific, and this is what appears to have actually happened. Similar changes may have occurred more than once in the earth's history since the remote time when the sial was spread over the whole globe.

It has been urged that the forces developed by the tidal action of the sun and moon, although large enough to cause a slow movement of the earth's crust as a whole, would not suffice to drive masses of sial through the sima, especially in the presence of the much larger compressive forces developed in the crust by the contraction of the earth's interior; still less to ruck up the earth's crust to form mountains tens of thousands of feet in height. It seems probable that this objection could also be urged against the adequacy for the same purposes of the forces developed by the variation of gravity from point to point on the globe, or against any combination of these two hypotheses.

To deal fully with this difficulty would involve the consideration of the principles of crustal compression and mountain-building, which I hope to discuss on another occasion. It will, I think, be at present sufficient to remark that, according to my view, it is precisely by the forces of compression that the crust has been folded and overthrust and the great mountain-chains raised up, but that the immediate result is the exhaustion, for the time being, of these forces and the simultaneous local destruction of the powers of resistance of the earth's crust, and that it is then and then only that the forces tending to cause the drifting of continental masses become free to act.

¹⁶ J. H. Jeans, *Phil. Trans. Roy. Soc., ser. A*, vol. 201 (1903), p. 157; W. J. Sollay, *Q. J. G. S.*, vol. 59 (1903), p. 180; A. E. H. Love, *Phil. Trans. Roy. Soc., ser. A*, vol. 207 (1908), p. 171, and *Nature*, vol. 76 (1907), p. 327.

Obituary.

DR. F. E. BEDDARD, F.R.S.

ZOOLOGY has lost a distinguished and devoted servant in the death of Frank Evers Beddard, which occurred at his home at Hampstead on July 14. He will be remembered best, perhaps, as the prosector of the Zoological Society: a post which he held for more than thirty years. He succeeded to great traditions, and worthily upheld them during his long term of office. Those who were privileged to listen to his discourses, at the scientific meetings of the Society, will ever remember his extraordinary facility of expression and the clear and rapid way in which he laid abstruse points before his audience. Few, probably, who were listening had ever made the dissections he was describing, yet so admirable was his presentation of the facts he had gleaned, that they could not fail to grasp the essential points laid before them. He had no rival in this regard.

Beddard's work on vertebrate anatomy covered a wide field, and though it may have been marked by no epoch-making discoveries, it maintained a high level of excellence. He has left, in the pages of the Proceedings

of the Zoological Society, a rich storehouse of information for future investigators. His contributions to science, in the form of original work, were, however, by no means confined to the vertebrates. He wrote a memoir on the Isopod Crustacea collected by the *Challenger* Expedition; and a fine monograph on the Oligochaeta, issued by the Clarendon Press. This was, perhaps, his favourite group, and embraces some of his best work.

In his books Beddard did himself less than justice. His volume on whales, for example, was good, but he could have given us a much better book. The same may be said of his volume on the classification of birds, and that on the coloration of animals. In these he seems to have shirked the labour of coming to a decision on the very vexed and controversial points which these two themes presented. He nowhere commits himself to a definite opinion as to whether he does or does not agree with the conclusions arrived at by others, whose views he sets forth without comment. His pages are almost too dispassionate to be helpful.

Beddard was elected a fellow of the Royal Society in 1892, and was the recipient of the Gold Medal of the

Linnean Society For some years he was lecturer on biology at Guy's Hospital, and he also acted in the capacity of examiner in morphology at Oxford, and in zoology and comparative anatomy in the University of London. Finally, he was a man of great personal charm, who was always willing to put his wide knowledge and experience as a zoologist at the service of others

W. P. P

WHILE many can speak of Dr F. E. Beddard's zoological work in general, there must be few who knew his special work on the Oligochaeta so well as myself For upwards of a quarter of a century we were in constant correspondence, exchanging papers, specimens or notes. It is forty years since he began to publish on the subject of annelids. Alongside of his professional work he had already spent at least ten years on the oligochaets before his *magnum opus* was issued by the Clarendon Press ("A Monograph of the Order Oligochaeta," 1895). In the bibliography appended to this work no fewer than eighty-five items are recorded as his own, while Benham and Friend are each credited with twenty Beddard did not profess to pay special attention to the British annelids, and very few of the species described in his monograph have indications that they may be found in Great Britain His own material came from every part of the globe, but the tropical worms were perhaps those he knew best. What he did for Asia in particular largely paved the way for the splendid work which Stephenson has done and is still doing When I took up the work in 1890, Beddard, together with Dr Benham, gave me every possible help; and as my work on British annelids, and particularly that on the Enchytraeids, grew, he regarded that department as mine, and left me an open field. He was ever ready to recognise the work of others, and never looked askance at one who worked as an amateur in the provinces with all the odds against him

In 1912 Beddard issued a little volume on "Earthworms and their Allies," but his output was so enormous that he had no time for cultivating a fine literary style. If he has left behind little, however, that would make worms popular with the general public, his monographs and memoirs will always remain as a tribute to his industry, and as a mine of wealth for the specialist He will long be remembered as England's foremost authority on the Oligochaeta

HILDERIC FRIEND

DR. S. T. DARLING

AN eloquent appreciation, from the pen of Prof. R W Hegner, of the life and work of Dr. Samuel Taylor Darling, of the League of Nations Malaria Commission, appears in a recent issue of *Science* Dr Darling, it will be remembered, was killed, with two other members of the Commission, on May 20 in a motor-car accident near Beirut in Syria. He is described by Prof Hegner as "one of the foremost American students of tropical medicine, especially in the field of medical zoology."

Dr Darling was born in 1872 and chose medicine as his career In 1903 he went to the Ancon Hospital in the Panama Canal Zone and three years later he was appointed chief of the laboratories of the Isthmian Canal Commission, a post which he held until 1915

During this time he took up the study of parasitic organisms causing diseases in man and animals and of malaria, and published some noteworthy papers on histoplasmosis, sarcosporidia, the malarial organism and its mosquito vectors, trypanosomiasis in horses, leishmaniasis, endamebae, and similar subjects In 1913-1914, Dr Darling accompanied General Gorgas on a sanitary mission to the Rand mines and Rhodesia and in 1915 he joined the staff of the International Health Board of the Rockefeller Foundation. As head of a medical mission of the Board he spent two years studying the causes of anaemia among the peoples of Malaya, Java, and Fiji. Some of the results of this mission appeared in a report, of which Dr Darling was part author, on "Hookworm and Malaria Research in Malaya, Java, and the Fiji Islands" He was then sent to Sao Paulo, Brazil, where he established a laboratory for teaching and investigation on these subjects, and in 1922, when the International Health Board decided to found a field laboratory for the study of malaria at Leesburg, Georgia, Dr. Darling was chosen as the first director Here, according to Prof. Hegner, he did some of his best work as an investigator and as a teacher, training men who were afterwards sent out on malaria control campaigns.

Dr Darling was an honorary fellow of the Royal Society of Tropical Medicine and Hygiene, president in 1924-25 of the American Society of Tropical Medicine, a member of many other American and foreign learned societies, and of the National Malaria Committee. His widow has presented his library to the Department of Medical Zoology of the School of Hygiene and Public Health, Johns Hopkins University, Baltimore, and it will be known as the Samuel Taylor Darling Library.

We regret to announce the following deaths:

Dr Charles W Burrows, formerly head of the magnetic section of the U S Bureau of Standard, who was distinguished for his work on magnetic testing and on the magnetic properties of alloys of iron, on May 2, aged fifty years

Dr David T Day, for twenty years head of the department of mining and mineral resources of the U S Geological Survey, who made a special study of the constitution of petroleum and its derivatives, on April 16, aged sixty-five years

Prof Louis Gentil, professor of physical geography at the Sorbonne, Paris, and member of the Paris Academy of Sciences, distinguished for his exploration work in Morocco and other parts of northern Africa, on June 12, aged fifty-six years

Dr J Guillardmood, a distinguished Swiss geographer and explorer and the author of several works on the Himalaya, on June 6, aged fifty-seven years

Dr I Minis Hays, secretary general of the International Medical Congress held at Philadelphia in 1876, and secretary since 1897 of the American Philosophical Society, on June 6, aged seventy-seven years

Prof F R Japp, FRS, emeritus professor of chemistry in the University of Aberdeen, on August 1, aged seventy-seven years

Dr E J McWeeney, professor of pathology and bacteriology in University College, Dublin (National University of Ireland), and bacteriologist to the Local Government Board, on June 20, aged sixty-one years.

Current Topics and Events.

THE German Chemical Society has recently published a "warning" directing attention to the very large numbers of young chemists now coming from the universities, many of whom are unable to find suitable employment. Figures are given showing the extraordinary increase in graduates from the chemical faculty, as compared with those from other departments of the universities. It is anticipated that the number of chemical graduates this year will be about 1100, whereas it is computed that German industry is only able to absorb about one-third of that number, that is to say, about 350 per annum. Opportunities abroad for German chemists are now considerably less than they were before the War, partly for political or sentimental reasons, and partly because of the growing tendency in most countries having industrial aspirations to develop their chemical industry by employing their own chemists to the almost total exclusion of the foreigner.

THE "warning" referred to above has aroused considerable discussion in the German technical press. One of the main points brought out in this discussion is that German industry, as a whole, does not avail itself of the help of chemical science nearly so much as it should do; and there are many important branches of industry which might profit from a greater appreciation of applied chemistry, but the chemist is almost wholly ignored or is given a quite subordinate status. This may sound a little strange, for the view has hitherto been prevalent in Great Britain that at least in Germany the chemist was fully appreciated. Be this as it may, another point emerging from the discussion in the press is that it is not altogether the fault of industry if the chemist is somewhat neglected in some branches of manufacture. It is urged that his training is often at fault: it is too academic. Others consider that the main difficulty is that too many leave the universities without troubling to take their degrees. However, the warning does not so much apply to these as to the men who take high places in chemistry, and are yet unable to find employment. It may be that many of them, in view of their supposed qualifications, want too high salaries to begin with, and German industry in its present rather poverty-stricken condition cannot afford high outlay on scientific research. As in Great Britain, the mistaken policy is often adopted of starting any retrenchment in the research department.

TWENTY-FIVE years ago, in Lahore, the Society for Promoting Scientific Knowledge was started by medical college students, supported later by professors and local medical practitioners, to do something towards educating the public in matters scientific, and in particular in matters of public health, sanitation and household hygiene. It was no light task when all but the promoters appeared apathetic; by steady persistence, however, recognition and popularity followed; by local subscriptions and a grant from the Punjab Government, the SPSK became firmly established, with its own large public

lecture hall. Branch societies were opened at various places in the Punjab and even in Kashmir. By the publication of a magazine and many leaflets in the vernacular, numerous public lectures and conversazioni, the Society does good work; the Society's functions are well attended by all classes with undoubted beneficial results. The future of the Society is full of promise, for it has enlisted the support of the most prominent government officers and citizens, with His Excellency the Governor of the Punjab as patron. The Society's silver jubilee was celebrated by a conversazione in the Chemical Laboratory of the University of Lahore and the Biological Laboratories of the Government College and a public meeting in the Society's Hall.

AT the recent conversazione of the Royal Society, exhibits of several types of steel containing nickel and chromium and offering a high resistance to corrosion were exhibited. The specimens shown by Sir Robert Hadfield included two new alloy steels which are notable for their permanence on exposure to the atmosphere and to fresh or salt waters, differing from the ordinary non-rusting chromium steels in being independent of heat treatment. The heating and cooling curves indicate a complete absence of critical points, and no change of phase is detected by microscopical examination, so that the structure remains homogeneous whatever be the heat treatment to which the steel is subjected. Riveting and brazing consequently have no effect on the capacity of the alloy for withstanding corrosion. The exhibit included turbine blades and test specimens showing the mechanical properties of the steel at atmospheric temperatures and at temperatures up to 650° C under prolonged loading, showing the absence of creep. Specimens were also arranged to illustrate the history of the attempts to improve the resistance of iron and steel to corrosion, rusting and scaling.

PROF. RAYMOND PEARL has endeavoured to estimate statistically the relation, if any, between the number of doctors per unit of population and the death rates observed for the same population (*Journ Amer Med. Assoc.*, 1925, vol. 84, p. 1024). It appears that for the thirty-four States of the United States investigated, there is no significant difference in the mortality rate of a community in 1920, whether that community had few or many doctors per unit of population. Two morals suggest themselves from this result. The first is that perhaps the chief social and human value of the physician is in alleviating suffering, rather than in preventing death, at which last task he must in every case ultimately fail. The second is that while there is a great difference between good doctors and poor doctors in respect of the result of their activities, there is no significant difference between a good doctor and no doctor at all.

WE learn from *Science* that the new building and laboratories of the Marine Biological Laboratory, Woods Hole, Massachusetts, were opened on July 3

Mr C. R. Crane, president of the board of trustees, made himself responsible for the cost of the new building beyond the original estimate of 100,000*l.* In all, a sum of 280,000*l.*, including gifts from the Rockefeller Foundation, the Carnegie Corporation, Mr John D. Rockefeller, Jr., and the Friendship Fund, was collected, and 180,000*l.* of this has been invested for endowment. Previous to this extension, the assets of the Laboratory were valued at 100,000*l.*, so that the trustees now have a property worth nearly 400,000*l.* to administer. The new building provides for an extension of the library, a lecture hall, offices, research rooms supplied with fresh and salt water for aquaria, photographic rooms, and so on.

THE report of the Valletta Museum for 1923-24 is largely taken up with accounts of excavations on prehistoric, Phœnician, and Roman sites. Two finds are particularly noteworthy. Neolithic debris at Hagiar Kim yielded a statuette in baked clay, consisting of the head and neck of a figure with horns coiled twice round the ears. The figure may be that of a ram, but is believed to be more probably human; it is 43 mm. high. At Mgar, where are, or were, extensive megalithic ruins, was found a model of a megalithic building, made of globigerina limestone. The model, which is 47 mm. long and 33 mm. high, represents an oval building of slabs on end with pillars between them, and roofed by eight horizontal slabs. The entrance is through a trilithon with a high sill.

OF the making of journals there is no end. The increase in the number of biological journals since the War has been surprising, yet they nearly all appear to fill a useful place in the development of science. The latest addition is called the *Archiv für experimentelle Zellforschung besonders Gewebezuchtung (Explantation)*, and aims at covering the field of tissue-culture, microdissection and similar experimental work with the cell. The general editor is Prof Rhoda Erdmann, of Berlin, and she is assisted by fourteen investigators in various countries, whose names are connected with these fields of research. Papers are accepted in English, German, French, and Italian. The first number, which we have recently received, begins with an extended Italian paper by G. Levi on the conservation and loss of independence of tissue cells in culture. Other papers deal with cultures of heart tissues and sarcoma cells. M. Thielmann describes culture experiments with stomatal plant cells, and Albert Fischer describes an apparatus for extracting the juice from parenchyma tissues. The number concludes with a list of the papers which have appeared in this field in the years 1920-1924, compiled by the editor, and covering thirteen pages. It is intended later to compile all the literature from the beginning of tissue culture. Any authors whose papers are not included in this list are asked to send the titles to the editor at Nassausche Strasse 17^{II}, Berlin-Wilmersdorf. This number of the journal contains 144 pages and one coloured plate. It is published by Gustav Fischer, Jena, and the price is 8 gold marks.

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THE autumn meeting of the Iron and Steel Institute will be held at the University, Birmingham, on September 9-11, under the presidency of Sir Frederick Mills, Bart. The programme includes papers on blast-furnace practice in India, high-frequency induction furnaces, properties of single iron crystals, moulding sands, and on various iron and steel equilibrium systems. Cheap travelling facilities are being granted by the railway companies.

THE Royal English Arboricultural Society has arranged for a number of visits to forests in different parts of England and Wales during the month of August. The visits are open to all who are interested in forests and woodlands. The summer meeting of the Society is being held at Norwich during the first week of September. Particulars can be obtained from the secretary, Mr. E. Davidson, Estate Office, Haydon Bridge, Northumberland.

THE Minister of Health has appointed the following committee "to draw up a practicable scheme of post-graduate medical education centred in London"—The Minister of Health (chairman), Sir Arthur Robinson, Lord Dawson of Penn, Sir Humphry Rolleston, Bt., Sir John Bland-Sutton, Bt., Sir Thomas Holder, Bt., Sir George Newman, Sir George Blacker, Dr. R. A. Bolam, Dr. H. G. Dain, Mr. H. J. Paterson, Dr. J. Parkinson, Dr. H. L. Eason, Prof. Hugh Maclean, Mr. A. E. Webb-Johnson.

AT a meeting of the Vienna Academy of Sciences on June 12, Dr. Oswald Redlich was re-elected president, and Dr. Richard Wettstein vice-president. Dr. William Exner of Vienna and Dr. Waldemar Chr. Brogger of Oslo were made honorary members. Dr. Niels Bohr of Copenhagen, Dr. Max von Laue of Berlin, and Dr. Eugen Korschelt of Marburg have been elected foreign corresponding members. The following awards were made: the Lieben prize to Dr. L. Meitner for publications in the *Zeitschrift für Physik* on β and γ rays of radioactive substances; the Hartinger prize to Dr. R. Kremann for work on the electrolysis of metal alloys, and also to Dr. L. Moser for work on quantitative analysis and the purification of gases. The prize of 1000 golden kronen for a work on the physiology and pathology of the effect of high altitudes offered by the Semmering Alpine Sanatorium, Austria, has not been awarded, but is offered again. The prize is intended for Austrians, but foreigners will be considered if their work is done in Austria. Papers should be sent to the Kanzlei of the Akademie der Wissenschaften, Wien I., Universitätsplatz 2, before December 31 of this year.

THE Smithsonian Institution at Washington has just issued its annual Exploration Pamphlet (Smithsonian Miscellaneous Collections, vol. 77, No. 2), of which rather more than half is devoted to archaeological and ethnographical investigations in the field during the past year. An expedition to China sent out under the joint auspices of the Freer Gallery of Art of the Smithsonian, and the Museum of Fine Arts, Boston, carried out successful investigations at I Chow, in the province of Chihli, and at several

localities in the province of Shensi. In these regions the sites of two ancient cities were traced and many mounds inspected. The first actual excavating was done at Yu-ho Chen, in the province of Honan, where two tombs of the Han Dynasty (206 B.C. to A.D. 221) were opened. Cultural objects from prehistoric times to the Han period were brought to light, including chariot-fittings, mirrors and arrow-points of bronze; one or two gold rings; much pottery, and many other interesting objects. In Florida Dr. J. Walter Fewkes excavated the large Weeden Mound, and brought to light a large collection of Indian skeletons, pottery, artifacts, and other material of prehistoric origin. This mound was found to consist of two distinct layers, a lower layer containing crude, undecorated pottery, and an upper layer which produced decorated pottery, each piece of which was "killed," or punctured to allow the escape of the spirit of the bowl. In Alabama he uncovered several interesting mounds, including one which would shortly have been submerged by the back water from the Wilson Dam at Muscle Shoals.

ONE of the principal features of the celebration at Amsterdam on October 25, 1924, of the jubilee of the foundation of stereochemistry by Le Bel and van't Hoff, was the delivery of a masterly review by Prof. Walden of Rostock (formerly of Riga) of the progress of stereochemistry during the intervening

fifty years. This review was printed in the Amsterdam *Chemisch Weekblad* of January 24, 1925, but has been appearing in a revised form in *Die Naturwissenschaften* (April 10-May 1). This revision has made it possible to include references to the literature published up to the end of 1924. The review is therefore as noteworthy for its completeness as for the masterly way in which the vast range of material has been marshalled into a well-ordered scheme.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned. Two or three assistant superintendents in the Geological Survey of India—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, London, S.W. 1 (August 15). A research officer in crop and animal husbandry under the Ministry of Agriculture for Northern Ireland—The Secretary to the Ministry, Wellington Place, Belfast (August 17). An assistant in the Pathological Laboratory, Harpenden, of the Ministry of Agriculture and Fisheries—The Secretary to the Ministry, 10 Whitehall Place, London, S.W. 1 (August 29). An assistant at the National Physical Laboratory to act as librarian and editor of publications—The Director, National Physical Laboratory, Teddington (August 31). An assistant in the department of natural history and zoology of the University of Edinburgh—The Secretary of the University (September 25).

Our Astronomical Column.

THE COMPANION OF SIRIUS — Prof. Eddington announced, at a recent lecture to the Cambridge Philosophical Society and the members of the International Astronomical Union, an interesting result arrived at by Dr. C. E. St. John at Mount Wilson Observatory. It has been found possible to photograph with the 100-inch reflector the spectrum of the companion of Sirius separately from that of the bright star. It is of type F and therefore its surface brightness is greater than that of the sun, from its very feeble luminosity its diameter is concluded to be about that of the planet Uranus, while its mass is three-quarters of that of the sun. Hence its density is enormously great, and it is a favourable object for Einstein's third astronomical test—that of the spectral shift. Single stars do not avail for determining this, since we cannot separate radial velocity from Einstein shift. But in this case, differential measures from Sirius are possible, the correction for orbital motion being well known.

The result is very striking, after allowing for orbital motion, an Einstein shift equivalent to a radial motion of 21 km./sec. was found. This was tested on a large number of lines, so that it appears to be well established. The result is very important in two ways. First, it gives a confirmation of the Einstein spectral shift stronger than we can obtain from the sun, where its value is only 0.6 km./sec., an amount that it is difficult to separate from pressure effects or systematic surface drifts. Secondly, it affords strong evidence of the truth of Prof. Eddington's conclusion, arrived at last year, that atoms when stripped of their outer electrons are capable of being packed to extraordinary density without departure from the gaseous state; the density deduced in this case is hundreds of times that of the metals. Details of the investigation will be awaited with interest, but

the well-known skill of Dr. St. John justifies us in receiving it with considerable confidence.

AN INDIAN ASTROLABE — In the *Heidelberger Akten der von-Portheim-Stiftung* (No. 13) (Heidelberg: Carl Winters Universitäts Buchhandlung, 1925, 4 gold marks) Dr. Josef Frank and Dr. Max Meyerhof have published a paper, "Ein Astrolab aus dem Indischen Mogulreiche," which gives a lengthy description of an astrolabe in the Kestner Museum at Hanover. In a bibliographical introduction, the authors give a list of four manuscripts and many printed memoirs on astrolabes consulted by them, not including those quoted in the course of the paper. Next follows a description of the instrument, which is of medium size, having a diameter of 84 mm., and a short account is given of the various problems of spherical astronomy and astrology to which the instrument can supply approximate solutions. For this purpose every planispherical astrolabe is furnished with a number of circular plates which fit in the rim of the "mother" or shallow circular trough on the front of the instrument. On these plates are engraved for various latitudes stereographic projections of the principal circles of the celestial sphere. The instrument in question has plates for the latitudes 18°, 21° 40' (Mecca), 24°, 27°, 32°, 35°, 39° 37', the last one being probably for use at Bokhara. An inscription on the triangular bracket carrying the ring, whereby the instrument is suspended, shows that it was made in A.H. 1018 (A.D. 1609) at Lahore by two brothers, sons of Isa b. Allahdad, and belonging to a family of astrolabe makers. Other inscriptions, mostly in Persian, give 37 names of towns (with longitudes and latitudes), chiefly in the Mogul Empire, but it is not unlikely that these inscriptions are due, not to the maker, but to a somewhat later owner.

Research Items.

RELIGIOUS BELIEFS IN THE SIMLA HILLS—Mr. H. A. Rose has communicated to the June and July issues of the *Indian Antiquary* a number of legends of the *devotas* or godlings of the Simla Hills, collected mostly from the district of Khumharsain by Pandit Sukh Chain. The legends cover seven families or groups, and in most cases give an account of the origin of the godling and its cult. In a number the serpent appears. Kot Ishwar, for example, who originated in the temple of Durga at Hat Koti and had been imprisoned by the magic of the Brahmans on account of his oppression of the people, in order that he might be thrown into the river, escaped and troubled the people in the form of a serpent, sucking milk from the cows. The same story of taking the milk from the cows in the form of a serpent is told of the *devota* Marech of Malindi. Kalu, the eldest of five brothers and a hermit, when he died became a snake living on Tikkar Hill who devoured men. He could draw people into his mouth from afar by his breath. Others of the godlings had a fondness for human flesh, and demanded human sacrifice. Dithu's favourite meal was a woman's breast, of which he ate one every day. He was arrested on the order of Kot Ishwar, and not released until he had sworn not to touch human flesh again.

SCULPTURED STONES FROM GORGONA, SOUTH AMERICA—In *Man* for July, Mr. Hornell continues his account of the archaic sculptured rocks found on the island of Gorgona by the *St. George* Expedition. On a second group of rocks the incised figures were very numerous, but greatly worn. The central boulder of the group is thickly set with small cups from an inch to an inch and a half in diameter, and half an inch in depth. At the ends are the figures of a frog and a bird, and on one side is a triangular axe lashed to a haft. On a ridged stone near by is a rude human face and a complicated, but symmetric, design of superimposed groovings. These designs appear to have been cut with stone implements, and a number of such implements have been found together with fragments of pottery. Embedded in the beach were numerous fragments of large stone troughs. One of four boulders with relatively modern engravings showed a head with a peculiar form of tailed cap which points to an Indian, possibly Inca, origin. Later investigations, on a second visit, suggest that the stones described in the previous communication were the sacred place of the island, while the second is probably secular. Two settlement sites were dug and showed that the inhabitants probably lived in pile-dwellings.

GEOLOGY OF THE TAUNGS STRATA—It will be remembered that the limestone block from which Prof. R. Dart chiselled out the fossil skull of *Australopithecus africanus* was brought to him by his colleague, Dr. R. B. Young, professor of geology in the University of the Witwatersrand, Johannesburg. On April 20 last Dr. Young read a paper to the Geological Society of South Africa on the cliff-limestone at Buxton, seven miles to the south-west of Taungs, from which the famous fossil was quarried in November 1924. From this paper (*Trans. Geol. Soc. S. Africa*, 1925, vol. 28, pp. 55-67) we learn that the cliff-limestone at Buxton was deposited at the eastern edge of the Kaap plateau by streams and springs issuing from the dolomitic limestone of that plateau. Dr. Young found that calcareous deposits were still being formed at various points along the eastern escarpment, and although he refuses to hazard an opinion as to the geological age of the cliff-limestone

exposed in the quarry at Buxton, it is clear that he does not think it can be older than the Pliocene and may be later. In this recent limestone deposit numerous and extensive caves and passages formed, many of them communicating by fissures with the surface of the plateau. The caves, when exposed on the face of the quarry at Buxton, were found to be filled by bedded sands, similar in texture to those of the Kalahari. Dr. Young sums up his opinion regarding the antiquity of *Australopithecus* in a concluding paragraph thus: "This conclusion applies to the skull of *Australopithecus*. The position in the quarry face from which it came . . . was a few feet to the left of the body of loose sand already described in detail. The limestone in which it was embedded was full of reddish sand and, as previously shown, probably formed part of the filling of an underground passage in the limestone. The loose sand had all the appearance of being water deposited, and possibly the skull was washed in from the surface. I may mention that the latter event seemed to me the more probable when, above the limestone cliff at Thoming, I came on an isolated, complete, and partly cleaned skull of a baboon which had obviously been removed along by surface water and might easily be washed into any opening in the rock." Dr. Young also found that baboons still frequent caves along the eastern escarpment of the Kaap plateau.

THE LAVALA WEED IN INDIA—The Lavala weed, *Cyperus rotundus*, probably reduces the crop yield in many fertile districts in India by 25 to 30 per cent., and in view of the great loss thus incurred S. B. Ranade (Mem. Dept. Agric., India, 13, No. 5) has fully investigated the life history of the plant with the view of ascertaining its most vulnerable points and the best means of effective eradication. Enormous quantities of "seeds" (calculated at fifty-four million per acre) are produced throughout the year, particularly in July and October, and prevention of flowering is therefore of paramount importance. Lavala is of geophilous habit, and establishes a subterranean tuber system as soon as the first aerial shoots have appeared, but not before. Consequently, if germinating seeds or tubers can be prevented from putting up aerial shoots, by means of judicious cultivation and weeding, it is possible to prevent fresh colonies from being formed. Established colonies in badly infested land penetrate three feet deep in the soil, and though repeated removal of the aerial parts at short intervals will eventually exhaust the tubers, the process is very slow. Experiments indicate the value of bringing the tubers to the surface by deep ploughing, as tubers exposed on the surface of the soil in hot weather, or not deeper than three inches deep in dry soil, are killed in eight days. The use of certain smother crops is also successful, sann hemp distinctly reducing the numbers of tubers in the soil, though other methods of covering were less useful. The best practical method of treatment seems to be continuous hot weather cultivation, in order to expose as many tubers as possible to the air, followed by a thick green manure crop ploughed in early, and again succeeded by a second dry season's continuous cultivation. Once clear, no difficulty should be experienced in keeping the land clean from further infection. The article includes details of many laboratory experiments yielding much information with regard to the propagation of *Cyperus* by tubers and on the effect of spraying with various chemicals.

HYDROGEN-ION CONCENTRATION AND CELL DIFFERENTIATION IN PLANTS—Dr. H. Pfeiffer of Bremen pub-

lishes a long and very interesting paper (in German) in vol. 24, No. 2, of the *New Phytologist*, in which he records his observations upon the relation between the P_n of the developing tissue and the process of differentiation, his data being obtained from studies of the secondary phloem of the dicotyledon. He has studied the crystallisation of calcium oxalate from solutions of different P_n and points out that the monoclinic crystals (raphides) are deposited at low (acid) P_n values, whilst the tetragonal (sphaeraphides) or amorphous forms are deposited from neutral or alkaline solutions. Pfeiffer then employs indicators upon plant sections, and concludes that this factor of P_n is probably of importance in determining the form of the crystalline deposit laid down in the living cells of the secondary phloem and cortex. Dr Pfeiffer further shows that thin-walled cells appear to be associated with a low P_n of the tissue during development, whilst in tissues that are more alkaline during development thick cellulose deposits are the rule.

INDIAN AMPULLARIIDÆ.—In 1920 the Zoological Survey of India, then under the Directorship of the late Dr T. N. Annandale, began a series of small monographs on the genera of the freshwater gastropod Mollusca of the Indian Empire as a basis for the accurate determination of those species, if any, that acted as the intermediate hosts of internal parasites mimical to man. The latest, and in some respects best, of these is a "Revision of the Indian Ampullariidæ," by Dr B. Prashad (Mem. Indian Mus., 8, No. 2). The author, who accepts Dall's classification for the family published in 1904, recognises two genera as being present in India—*Pila* of Bolten, to which belong the common forms found in the plains, and *Turbinicola* of Annandale and Prashad, embracing the hill-stream species. Nine species of the former, including *P. robusta*, n. sp., and two of the latter are carefully and adequately described almost entirely from the conchological aspect, and for the first time in the series a properly worked out synonymy is prefixed to each, thus greatly enhancing the value of the work. The three plates of shells prepared from untouched photographs by the artists of the Survey well deserve the commendation bestowed upon them by the author.

GEOCHEMICAL DATA.—Those interested in the study of rocks and minerals, more especially in relation to geochemical processes, will welcome the recently published fifth edition of Dr F. W. Clarke's "Data of Geochemistry" (Bull. 770, U.S. Geol. Surv., 1924). The first edition of this very useful bulletin was published in 1908, being followed by later editions in 1911, 1916, and 1920. The work has been revised for the present edition, which, with its 841 pages, has ten more than the previous one. The author does not pretend that the book is an exhaustive monograph on geochemistry. He modestly claims that it presents to the reader a critical summary of what is now known about this subject, and serves as a guide to the more important literature. He gives little attention to merely speculative matters, preferring, in accordance with the title of the book, to set out the available data. These relate not only to rocks and rock-minerals, but also to coal, petroleum, and metallic ores. Chapters are given to the chemical elements, the atmosphere, lake and river waters, ocean waters, well and spring waters, saline residues, volcanic gases and magmas. The book is a model of accuracy and terseness. Probably none of the other publications of the United States Geological Survey has attained such a wide and well-deserved popularity among students of chemical

mineralogy and geology. It is already so well known that it seems almost superfluous to recommend it to any one interested in the data of geochemistry.

THE ORIGIN OF THE RYDBERG SERIES.—In *Die Naturwissenschaften* of July 3, Prof. A. Landé of Tübingen raises the question, "Why do the chemical elements fall into periods of 2, 8, 8, 18, 18, 32?" A novel answer is given to this question, since by taking into account the four series of quantum numbers (n, K, J, m) indicated by the analysis of spectra, it appears that the total number of options is 2, 8, 18 and 32 for the cases in which $n = 1, 2, 3$ and 4. There is therefore only one electron for each option, and no two electrons need be assigned the same series of four quantum-numbers, even in the case of the more complex atoms. This classification of orbits is, however, different from that which was in vogue a year or two earlier, and depends on assigning to K the quantum numbers $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}$, etc., instead of the integers which were used at an earlier stage.

MONOMOLECULAR FILMS ON WATER.—A paper on this subject, by W. D. Harkins and E. H. Grafton, appears in the May issue of the *Journal of the American Chemical Society*. The areas occupied in films by the molecules of various hydroxy-derivatives of benzene were determined by surface tension measurements of their solutions. The results indicate that while phenol, pyrocatechol, resorcinol and pyrogallol give "condensed" films (i.e. films of low compressibility), these films are nevertheless not "closely packed." All the substances investigated give expanded or "gaseous" films at lower concentrations of the solutions. It is probable that the hydroxyl group turns towards the water, while the phenyl group is on edge or on end above it. With *o*-hydroquinol, however, both hydroxyl groups are immersed in the water, while the phenylene group remains on the surface.

TESTING RADIO-TRANSMITTING ANTENNÆ.—A serious difficulty in connexion with experimental research on the best shape of the antennæ used in radio communication is that in practice the radiating systems used are very elaborate and costly. Once these systems are erected their heavy initial cost makes it imperative that they be operated commercially as soon as possible, and very little time is available for scientific investigations. The research bulletin issued last May by the University of Illinois dealing with the question as to whether the action of antennæ can be investigated by means of models is therefore a timely one. The author, Mr. J. Tykociner, adopts two theorems proved by Max Abraham about thirty years ago. They are that if we have two geometrically similar oscillators, their natural periods are proportional to the lengths of their respective segments, and they also have equal logarithmic decrements. The assumption is made that the ohmic resistance of the conductors is zero; the decrement is supposed to be due, therefore, to the radiation resistance. A proof is given that the radiation resistance of a model antenna is approximately equal to that of the original antenna. The smaller the model, therefore, the higher becomes its fundamental frequency as compared with that of the real antenna. Full instructions are given for making model antennæ. It is shown that the working characteristics of full-sized antennæ can be predicted with a maximum inaccuracy of about one per cent. by this method. Exceedingly short waves are used in the experiments, their wavelengths being less than 10 metres. They do not disturb, therefore, commercial radio traffic, and the errors due to the interference of commercial radio stations are negligibly small.

Filter-passing Viruses in Disease.

AT the Bath meeting of the British Medical Association a discussion on the filter-passing viruses occupied the first day of the meeting of the Section of Pathology and Bacteriology. The discussion was opened by Dr W. E. Gye. Dr. Gye criticised the expression "filter-passing viruses," which is generally used to include certain viruses which have hitherto not been proved to be filterable. The use of the term "filterable viruses," though convenient, has at present no real significance. His own experience has been particularly with Rous's chicken sarcoma, and even with this virus, filtration can only be conducted if certain experimental conditions are observed. If the tumour emulsion be insufficiently diluted, and if distilled water be employed instead of saline, the filtration is much more difficult, and it is seldom that an infective filtrate is obtained. By using a small volume of saline, or by using distilled water as a diluent, one obtains a viscous solution of mucin and nucleo-protein which will not pass the filter readily. The hydrogen ion concentration of the liquid also affects the rate of filtration, within limits not yet exactly determined, acidity increases the difficulty of filtration and alkalinity makes the process easier. The properties of the liquid in which the virus is suspended thus play an important part in the results of filtration.

A further important factor in filtration is the adsorptive capacity of the filter. Under certain conditions the filtrates of the infective material in Rous's sarcoma failed owing to the adsorption of the virus on the surfaces of the filter. The only method readily available by which the particulate character of viruses can be tested is that provided by the centrifuge. In the case of Rous's sarcoma, long centrifugalisation, at 8000 revolutions a minute at least, is necessary to obtain a definite difference in the infective actions of the upper and the lower layers. There is an urgent need for a machine which will spin at a higher speed with safety and is so constructed that fluids can be spun without running the risk of contamination. It is very improbable, however, that we shall ever get a centrifuge with which it will be possible to spin out completely an organism of the size, roughly, of 0.1μ .

The identification of the filterable viruses by staining methods is beset with fallacies, and the results obtained up to now have proved in the main disappointing. The microscope proved of very little value except in revealing contaminating microbes. It is possible that, with increasing knowledge of the ultramicroscopic organisms, we shall find that the doctrine of fixity of form holds here as well as with ordinary microbes. With regard to the cultivation of the filterable viruses, each virus must be considered by itself. The virus of pleuro-pneumonia is apparently the only organism of this group that grows readily on artificial media. The production of cloudiness in Noguchi tubes, which has been put forward as a proof of culture, so far as chicken sarcoma is concerned, is entirely erroneous.

The animal test provides the final proof of the presence of the organism in an inoculum. The difficulty of microscopic investigation in this field makes us fall back in a very special way upon animal experimentation. It is because ordinary laboratory animals are not susceptible or only slightly so to human filterable viruses such as measles or influenza that such small progress has been made. We shall be compelled to work at animal diseases if we want to discover a method of handling and identifying the very small microbes. This will,

however, involve great expense and is open only to those who have ample funds behind them.

In addition to his opening address (which was circulated but not read) on the more general aspects of the filterable viruses, Dr. Gye also discussed some aspects of the recent work he has done in collaboration with Mr. J. E. Barnard on cancer. The mere conjunction of host and parasite does not necessarily produce disease. There are accessory factors that must be searched for. Some years ago Dr. Gye and Dr. Cramer investigated the accessory action of certain chemical substances in the production of gas gangrene, and Dr. Gye had formed the opinion that the conception of disease as being due to the conjunction of living organisms involving a non-living factor was capable of further development. In this way he was led to his experiments on cancer. Any theory of cancer had to provide an explanation of its particular specificity both as regards the animal species the tumour is able to attack, and the type of growth produced. Yet cancer can be looked at from some points of view as one homogeneous specific disease, which has probably some common cause underlying it. The difficulty of obtaining a theory of cancer capable of reconciling the "specificity" of new growths with the general properties they hold in common has been overcome, in Dr. Gye's opinion, by his experimental work on Rous's sarcomas.

The infective filtrates of ground-up Rous's tumours contain not the virus only, but also an accessory substance or substances which are necessary to produce the disease. The accessory substances are responsible for the more specific peculiarities of the tumour, such as its histological structure and the susceptibility of certain animals to it.

The actual virus is probably the same in every case, and by means of prolonged spinning in a centrifuge, the virus may be obtained apparently free from the other factors. By suitable treatment with chloroform the virus can be destroyed without affecting the "specific factor." Neither the virus nor the accessory factor is separately able to produce sarcoma. The fact that "virus factor" from human carcinoma is able to produce sarcoma in the chicken if reinforced by the "non-virus" or "specific" factor from Rous's tumour brings the infectious sarcomas into line with the mammalian tumours, which up to now have been considered by most authorities to be non-infectious.

Mr J. E. Barnard followed Dr. Gye with an account of the optical part of the work they have done on cancer. He dwelt on the limitations of microscopical research into filter-passing viruses, and stated his opinion that the present dark ground illumination apparatus such as is used at the National Institute for Medical Research is of such perfection that further improvement in direct microscopy upon present lines cannot be expected. The method which has proved so valuable in his and Dr. Gye's work depends upon the use of an apparatus by which the object can be focussed in visible light, and by a mechanical device can be refocussed in any desired wave-length, and thus a photomicrograph is obtained using light with a very short wave-length. What is believed to be the virus of cancer has thus been photographed, and what are considered to be phenomena of growth were seen in the preparations. The real difficulties in the work depend upon biological rather than physical considerations. The material is, in fact, more important than the apparatus, and much depends upon the absorptive capacity for light of the media, and

of the virus itself. The study of the absorption of the material will be the key of further optical improvement in microscopy.

Dr M. H. Gordon dealt with the problem of the filter-passing viruses in the light of his experimental work on vaccinia and variola. These diseases are particularly suitable for the preliminary attack on the problem since a small animal is available that is susceptible to the virus, and the lesions produced by the virus are so characteristic that there is no likelihood that they will be mistaken for accidental lesions. In his work Dr. Gordon decided that since the cultivation of the virus and any attempts to make it visible by microscopic means are beset with difficulties, the most promising line of attack is by the methods of immunity. Vaccinia also satisfied the criterion of particulate matter, and centrifugalisation can separate infectious material into layers of varying infectiousness. Vaccinia is filterable, but only with special precautions, *e.g.* after previous treatment of the material with trypsin.

Active immunity to vaccinia can be produced not only by normal living virus but also by means of heated attenuated virus. In rabbits a passive immunity can also be transferred. Agglutination and complement fixation experiments have been done with the virus and its immune serum. Agglutination of the virus is easily visible with the naked eye or with a hand lens. Preparations of the agglutinated material show objects which bear a close resemblance to those figured by Dr. Gye and Mr. Barnard in their paper on cancer. The use of the agglutination method has given some interesting results. Material from confluent smallpox and from the so-called Alastrim absorbs the agglutinin in the same way as the homologous virus of vaccinia. From the point of view of agglutination, the close relationship, if not identity, of these three diseases was confirmed. Dr. Gordon finds a very striking susceptibility of vaccinia virus to potassium permanganate, which is more destructive than the customary disinfectants. Potassium permanganate in 1 in 100,000 dilution destroys

the virus in a short time. This curious susceptibility of the virus may, indeed, to some extent, explain the result credited to this drug in the treatment of smallpox. Dr. J. E. McCartney stated that in the case of herpes virus he has been unable to separate virus from its suspension fluid by means of spinning. This he ascribed to the activity of the virus at much greater dilutions than that of the sarcoma or vaccinia viruses.

As was to be expected from the great interest that has recently been taken in the action of light and other physical agents in medicine, this subject was also prominent at the Bath meeting. Three discussions dealing with different aspects of this subject were included in the programme. Prof. S. Russ opened a discussion on the pathological basis of treatment by radiation with a general statement of the physical problems involved. Dr. E. T. Strangeways gave an account of experiments on the effect of X-rays on the division and development of tissue cells grown *in vitro*. He has been able to kill chick embryos while in the shell with X-rays, though after death of the embryo as a whole, successful tissue cultivation could still be made.

Miss M. E. Hume discussed the action of ultra-violet light on rickets, and the relation of light effects due to vitamin A. Dr. Canti described the action of radium on the mitosis of cells in human carcinoma.

In the Section of Therapeutics, Prof. W. E. Dixon opened a discussion on the therapeutic action of light; and in the Section of Public Medicine, Prof. Leonard Hill dealt with the influence of sunlight and artificial light on health. In all these communications there was the healthy sign that this branch of medicine, which a short time ago was in an empirical state, is now rapidly being co-ordinated on a scientific and experimental basis. Prof. Russ's concluding remarks seem to sum up the present position with regard to this branch of experimental medicine. "There is nothing so depressing as being told that we are only at the beginning of the subject. I do not think that this is the case, but rather that we are well in the middle of it."

Strong Electrolytes.

A SERIES of papers on the activities of strong electrolytes, by G. Scatchard, appears in the Journal of the American Chemical Society for March. The activity of hydrochloric acid was obtained from measurements of the E.M.F. of the cell $\text{Pt}(\text{H}_2)/\text{HCl}, \text{AgCl}/\text{Ag}$. The hydrogen electrode was of a rocking pattern suitable for use in a thermostat and simplified by the absence of a liquid junction. The activity coefficients obtained agree with those calculated from Randall and Vanselow's freezing-point measurements; the values at low concentrations are consistent with Debye and Huckel's limiting equation, the theoretical value of the constant in that equation being retained. The activities of potassium, sodium, and lithium chlorides are also considered, the existing data are compared and discussed in the light of Debye and Huckel's theory.

Individual ion activities have always been calculated through one of three assumptions, namely, (1) that the activities of the ions in a uni-univalent electrolyte are equal; (2) that the above is true in the case of potassium chloride, and that the activity of an ion depends only upon the total ionic concentration and not on the ions with which it is associated; (3) that the saturated potassium chloride bridge eliminates liquid-junction potentials. Assumptions (1) and (2) are in general incompatible; assumption (3), however, is quite distinct and is compared with the first two by G. Scatchard by measuring the E.M.F.'s of the cells,

$\text{Pt}(\text{H}_2)/\text{HCl}, \text{AgCl}/\text{Ag}$ and $\text{Hg}/\text{HgCl}, \text{KCl}(\text{sat.})/\text{HCl}/\text{AgCl}/\text{Ag}$, the latter containing a flowing junction.

The results indicate that assumption (2) above is correct and that the saturated potassium chloride bridge gives a liquid-junction which does not vary with the acid concentration. The liquid-junction potential alters slightly on stopping the flow. In more concentrated solutions the chloride ion appears to attain a maximum activity, whilst that of the hydrogen ion appears to drop to a minimum value. The results obtained enable certain single electrode potentials to be accurately calculated.

From a series of papers by H. S. Harned on the subject in the same issue of the Journal of the American Chemical Society, the activity coefficient and the vapour pressures of the solutions are calculated from the E.M.F. of the cell $\text{H}_2/\text{NaOH}(c_1)/\text{NaHg}/\text{NaOH}(c_2)/\text{H}_2$. The activity coefficient of potassium hydroxide is greater than that of sodium hydroxide at concentrations greater than 0.05 molar. In the presence of sodium chloride the logarithm of the activity of the hydroxide (concentration less than 0.5 molar) is a linear function of its concentration at constant total molality. For potassium hydroxide in potassium chloride solution the activity coefficient is greater than that of sodium hydroxide in a sodium chloride solution when the hydroxides and salts are at the same strength. W. Lucasse records the activity coefficients and transport numbers of the alkaline-earth chlorides in the same journal.

The Sixth International Congress of Photography.

DURING the period June 29–July 6 there was held in Paris an International Congress on Photography, the purpose of which was to consider questions of standardisation in both pure photography and cinematography. The last Congress was held in Brussels in 1910, and was to have been succeeded by a Congress in London in 1915, but unfortunately the War intervened.

One of the reasons for holding the Congress this year in Paris was that it is the centenary of the discovery—according to French claims—of photography by Nicéphore Niepce; at the same time a plaque to the memory of Daguerre was unveiled. Attending the Congress were delegates from the United States, Belgium, England, France, Germany, Holland, Italy, Japan, Spain, and other countries. It was especially noticeable that there was nothing wanting in the cordiality with which the Germans were received, political questions were entirely put aside, it being realised that all the members had met for the furtherance of a common cause. Discussions were carried on in English, French, and German.

The Congress was opened on Monday afternoon, June 29, by Prof. Fabry of the Sorbonne, who is at the same time the president of the French Photographic Society. One delegate from each of the countries represented was elected as vice-president, and these presided in turn at the various sessions. The general arrangements were in the hands of MM. Clerc, Labussière, and Lobel.

For some time previous to the Congress an English committee, appointed by the Royal Photographic Society, had been at work in drawing up recommendations with respect to a standard light source; exposure mechanism; development and subsequent

treatment, the measurement of density, and the interpretation and statement of results. These recommendations were submitted to the Congress committee in sufficient time for them to be translated into French and German and circulated among the members. Recommendations were also received from the Optical Society of America with respect to the standard light source. It is significant that these recommendations formed the main basis of discussion. Agreement was arrived at between the various interests represented, and definite resolutions, embodying most of the recommendations of the English committee, were passed, but will not come into force until after a period of six months. The cinematography section was also able to harmonise the various points of view held by the different countries represented. An international executive sub-committee was appointed, with M. Clerc as secretary, and it was resolved that the next Congress should be held three years hence, and that the place of meeting should be, if possible, in London.

In addition to the various meetings of the sections there were functions of a less arduous character, including a reception at the Hôtel de Ville de Paris by M. Guillaumin, President of the Municipal Council, and a soirée, in the large amphitheatre of the Sorbonne, to commemorate the centenary of the invention of photography, at which the President of the French Republic, M. Doumergue, was present. A visit was made to the works and studios of M. Gaumont, and there were motor-car excursions to Ermenonville, Chailly, and Senlis, and to the forest and chateau of Fontainebleau. The actual proceedings of the Congress were terminated on Saturday, July 4, by the usual banquet. T. SLATER PRICE.

Fishery Investigations.

THE Ministry of Agriculture and Fisheries has recently issued a report on sea fisheries for the years 1919–23; the last one (for the period 1915–1918) being published in 1920. This is a great pity, because both reports have been so very interesting. The 1920 report gave an engrossing account of the part played by British fishermen in the War, while the present one (H.M.S.O., 1925, 3s. 6d. net) deals, in an equally agreeable way, with the gradual settling down towards normal conditions of the sea-fishing industry. Statistical tables, summarising the catches made and other numerical results of the Ministry's work, have been issued each year, and the report now available discusses, in a general way, the information that has been collected. There is a very good summary of the scientific investigations made during the post-War years, and there are a number of clear financial statements showing the cost of the various kinds of work, administrative, developmental and scientific, undertaken by the Ministry.

Three parts of the Ministry's publication, "Fishery Investigations," have recently been published. No. 6, vol. 6, Ser. II, "The Annual Cycle in the Life of the Mature Cod in the North Sea," by Michael Graham and collaborators, deals with the investigations, biological and statistical, made during the last few years (H.M.S.O., 1924, 13s. net). No. 2, vol. 7, Ser. II, "Report on Exploratory Voyages to Lousy Bank and Adjacent Areas," by Lieut. Pawsey, G. T. Atkinson, and H. H. Goodchild, describes some very careful work done in the investigation of a new fishing-bank north from Rockall (H.M.S.O., 1924, 3s. net). No. 6, vol. 7, Ser. II, "Report on the English Plaiçe

Investigations in the North Sea during the Years 1921–1923," by J. O. Borley and Miss D. E. Thurst, Pelham (H.M.S.O., 1925, 13s. net), is a very clear, written and readable account of the investigations that have been made since the War on the apparent increase in the plaice stock of the North Sea as a result of the great decrease in fishing during the period of military operations and restrictions. The results of the international inquiries and the recommendations that were made are also given. It contains a very good bibliography and is a very important work.

Some notable publications of the International Council for the Exploration of the Sea have also appeared recently. Dr. Martin Knudsen has prepared a *Bulletin Hydrographique* (1924), dealing in a general way with the observations made during the years 1920–1–2–3. Dr. Ed. le Danois has edited the *Rapport Atlantique (Rapports et Procès-Verbaux, vol. 35, January, 1925)*. This contains the results of the investigations made by the "Atlantic Slope Committee," and it includes a very interesting discussion of the transgressions of Atlantic oceanic water into the shallow European seas. There is a discussion of the relation of this oscillatory movement of superficial Atlantic water to the long periodic tides. *Publication de Circonstance, No. 84* (1924), is a description, in English, by Messrs. Ostenfeld and Jespersen, of the "standard plankton net" which was to have been designed by the late E. W. Nelson. The instrument is a modified "Nansen net," hauled in the way devised by Mr. H. J. Buchanan Wollaston of the English Fishery Investigations Staff. J. J.

University and Educational Intelligence.

AN Aitchison Memorial Scholarship, of the value of 36*l.* and tenable for two years in the full-time day course in technical optics, at the Northampton Polytechnic Institute (London), is being offered to students of both sexes. The examination will be held on September 22 and 23. Particulars can be obtained from the Hon. Secretary and Treasurer, Mr. Henry Purser, 42 Grays Inn Road, London, W.C.1.

THE Air Ministry announces that the next examination of candidates for entry as flight cadets to the Royal Air Force Cadet College, Cranwell, will begin on November 17, when 35 cadetships will be offered. Forms of entry, which can be obtained from the Secretary, Civil Service Commission, Burlington Gardens, W.1., will not be accepted later than September 17. Candidates must be medically fit and be between the ages of 17½ and 19½ years. Cadets undergo a two years' course at the College, where, in addition to continuing their general education, they receive a thorough training in all questions concerning military aviation and cognate subjects, and also graduate as service pilots. Full details as to entry into Cranwell are contained in Air Publication 121, Regulations for admission to the Royal Air Force Cadet College (H.M. Stationery Office, Kingsway, W.C.2, 6*d.* net).

THE universities receive each year from the grant-aided schools in England and Wales 4½ per cent. of the total number of pupils leaving the schools. The president of the Board of Education recently directed attention to this percentage as being abnormally small. In the United States, according to an article in the April issue of *School Life*, 350,000 boys and girls—six times as many as a quarter of a century ago—will be completing their public high-school course this year, and of this number 112,000 will go to college and 50,000 will enter other institutions to continue their education. This abundant supply of recruits for post-secondary education affords evidence of widespread prosperity, but their acceptance is not an un-mixed advantage either to them or to the institutions receiving them. The president of the Carnegie Foundation for the Advancement of Teaching says in his annual report for 1923-24 that the colleges and professional schools admit each year a growing army of high-school graduates who lack the qualities of intellectual training which would fit them for fruitful college study, for they have not learned to use their minds. This is in some measure due to the gradual substitution of a new ideal of the meaning of a liberal education for the old-time conception of training the habits and powers of the mind. The mere acquisition of knowledge, formerly regarded as a secondary matter, has become the main thing. "Our high schools and colleges seek to give their pupils something from every field of thought. Following the advice of Herbert Spencer they labour to present these packages of knowledge in the most agreeable forms. The textbooks offer every variety of predigested knowledge. . . . It is exactly the reverse of that intellectual training which the study of science ought to bring." One of the most pressing needs of the time, moreover, is to diminish the subserviency of the school to the college and to open up from the elementary and from the secondary schools leadings to technical schools in the trades, in agriculture, and in the arts. The vocational courses given in the high school are no substitute for "the sharp, precise training that makes for the sort of technical skill that adds joy to work and is one of the most prolific sources of human happiness."

Early Science at Oxford.

August 12, 1684 (*continued*). Dr. Alexander Pudsey, Fellow of Magdalen College, subscribed to ye Articles, and then sate as President.

Dr. Plot communicated some of ye bark of ye clove tree; it had a strong aromattick tast, very much like cloves, and very differing from Cinnamon, which has sometimes been thought to be ye bark of this tree. He communicated also some patterns of firr, taken up in ye old *dewet pool*, in ye parish of Norbury in Staffordshire, so full of Turpentine, that it is transparent; this is that which they use as candles. and may well be thought to have adventitious Bitumen from ye moores, wherein it lies; for forreign firr is not so transparent, will not burn so well; and that this is firr, appears very probable, because some of ye trees taken up, have six branches at ye annuall distances, which, as ye Doctor thinkes, no trees, but firrs, have.

August 19, 1684. The Society being met, ye following experiments were tried, by Mr. Musgrave.

Human spittle, clarified by standing, being mix't with syrup of violets, turned to a delicate *green* color. Part of a Mucous substance, taken out of ye Stomach of a Jack near ye Pylorus, and mixt with solution of sublimate, became much whiter, than it was before. Another part of it, mix't with syrup of violets, turned *green*.

The same person has observ'd like effects, by mixing a liquor found in ye stomach of a *Hedghog*, with syrup of violets, and with solution of sublimate.

These Experiments are urged as an argument against ye existence of an *acid ferment* in ye stomach. It seems probable, that ye great worke of Digestion proceeds from a *volatile alkali*.

He also tooke notice of a large *bed of Glands*, making about ye ⅓ths of ye inside of ye stomach, and seated near ye pylorus, of a Jack; the whole bed appears of a brownish red color, and is divided into severall Ridges, which run parallel to one another, and ye same way with ye stomach; for ye better contraction of that part especially when empty, (at which time these Glands being fix'd to the inmost coat, are, together with it, drawn up into wrinkles), that edge of this bed of glands, which is nearest ye head of ye fish, is dented, ye ridges breaking off on a sudden; but at ye other end, on this side ye Pylorus, they diminish almost insensibly.

By these Glands, he supposes, at least a considerable share of ye menstruum (the great efficacy of which makes this fish a fit subject to illustrate ye nature of Digestion) is seperated from ye blood; for blood vessels may be seen in great numbers on ye other side of ye glands, and inner tunic, by seperating it, and them, from the middle and muscucose tunic; and, as a farther argument of this use of ye glands, he has observed, that that part of ye stomach where they are, is generally moister, then the other part near ye mouth; and that, in dissecting Jacks, whose stomachs have been filld with some large fish of ye pinnaceous kind, (which must enter with ye head foremost) ye head, and foremost parts, of ye devoured fish, have, as far as the glands reach, been either actually dissolv'd, or fairly turning, into a mucilage; whereas, at ye same time, ye other, and less bony, part of ye included fish, being not yet come within ye power of the menstruum, has still retain'd its form, and consistence.

Mr. Walker presented ye Society with ye draughts, and descriptions, of two sorts of Wooden Bridges, contrived without any pillar under them, tho of a considerable length; these accounts will be printed very suddenly.

Societies and Academies.

LONDON.

Faraday Society, July 6—A. L. Marshall: The electrodeposition of zinc from sulphate solutions. With pure solutions, the efficiency of zinc deposition always increases with rising temperature; an explanation based on chemical polarisation is given. A convenient copper coulometer has been developed for measuring currents up to 15 amperes or more.—J. B. O'Sullivan: The application of the quinhydrone electrode to the measurement of P_H values in solutions containing copper ions and other divalent ions. The quinhydrone electrode can be employed in many cases in which the ordinary hydrogen electrode cannot be used on account of its greater reducing power. This applies not merely to salts of copper, which are electro-positive towards hydrogen, but also to neutral or weakly acid solutions of the salts of such metals as tin, lead and nickel. The quinhydrone electrode is itself limited in its applicability by its reducing power. Thus it cannot be employed even in moderately acid solutions of the salts of mercury, silver or gold, which have normal electrode potentials of more than 0.7 volt.—F. M. Cray and G. M. Westrip: The preparation of solutions of standard hydrogen ion concentration and the measurement of indicator ranges in an acetone-water mixture. Solutions of standard hydrogen ion concentration ranging from P_H 12.5-2.0 have been prepared and calibrated by means of the quinhydrone electrode in a solvent containing 10 volumes of water in 100 of acetone-water. These solutions have been used in the measurement of the P_H ranges of a large number of indicators in the specified solvent. Their behaviour in these standard solutions is consistent with their P_H values, as determined by the quinhydrone electrode, within 0.1 P_H .

DUBLIN.

Royal Irish Academy, June 22—A. K. Macbeth and J. Craik: Condensation reactions of indoxyl and 3-oxy(1)thionaphthen. In the course of some work, a trustworthy method of estimating 3-oxy(1)thionaphthen was found necessary, and its condensation reactions with several aldehydes were therefore examined in some detail. Typical condensation products were formed by the interaction of the thioindoxyl and anthraquinone-2-aldehyde, 5-nitroanthraquinone-2-aldehyde, 1-chloroanthraquinone-2-aldehyde, and isatin. The condensations take place quantitatively and the thioindogenides produced are characterised by their high melting points and marked insolubility in organic solvents. The reactions are therefore of value in estimating 3-oxy(1)thionaphthen. The indogenides obtained by the condensation of indoxyl with anthraquinone aldehydes were prepared for comparison with the series of thioindogenides. The latter were all found to be yellow-coloured compounds in contrast with the deep-red or brown products obtained in the former case.

EDINBURGH.

Royal Society, June 22—W. H. Lang: Contributions to the flora of the Old Red Sandstone of Scotland. (a) On plant-remains from the fish-beds of Cromarty. (b) On a sporangium-bearing branch-system from the Stromness beds. Plant-remains from the grey clay or micaceous sandstones of the Cromarty fish-beds include more than eight distinct types of spores and two types of sporangia found free in the rock. Some features of the vegetative organs

of *Thursophyton Milleri* are described, but nothing is yet known of the reproductive organs of this plant. The smooth, branched axes are referred to *Hostimella* sp. and some of them have axillary structures like those recorded for *Hostimella hostimensis* from Bohemia. Two types of plants with attached sporangia containing spores are named provisionally *Hostimella globosa* and *H. pinnata*. Large oval sporangia, borne on a raceme-like branch-system, from the Stromness beds of the same age are named *H. racemosa*.—F. A. E. Crew: Rejuvenation of the aged fowl through thyroid medication. Cock-feathered cocks become hen-feathered: the plumage of hen-feathered cocks and of hens is unaffected save that there is an increased melanism. The egg-yield is increased and old birds are rejuvenated.—A. Crichton Mitchell: On the changes in vertical force during the "sudden commencement" of a magnetic storm. The "sudden commencement" of the slight magnetic storm of Sept. 4, 1924, was observed at Eskdalemuir Observatory by means of a large coil laid horizontally on the ground, the current induced in the coil by the sudden change in vertical force being recorded photographically by a galvanometer in the circuit.

ADELAIDE.

Royal Society of South Australia, May 14—L. Keith Ward: Notes on the geological structure of Central Australia. The salient features of both the fundamental complex forming the core of the MacDonnell Ranges and of the sediments deposited upon these foundations in the central portion of Australia are described. The palaeontological and stratigraphical data, when correlated, are regarded as proof of the exclusion of the supposed Cambrian system from the central area and the existence of an immensely thick series of Ordovician sandstones and limestones. These are overlain, in the southern part of the Northern Territory, by beds comprising glacial tillites—presumably of Permo-Carboniferous age. Then follow successively Jurassic sands, Lower and Middle Cretaceous shales, and recent deposits of fluvial and æolian origin. A dense crust of chalcedonic silica caps alike the Ordovician, Permo-Carboniferous, and Cretaceous rocks. Glacial action in Upper Cretaceous time was widespread through the northern part of South Australia. The correlation of the formations described with those of adjoining regions is discussed, and the evolution of the structure outlined. The great central depression of Australia exerted an important influence on the development of the drainage system.

CAPE TOWN.

Royal Society of South Africa, May 20—S. H. Haughton: Tracks of animals preserved in the Ecca Shales of the Cape Province. The specimens are from two localities in the Ecca Beds, one in the Zak River area, Calvinia, and the other from the cutting (Ecca Pass) on the road from Grahamstown to Fort Beaufort, localities separated by a distance of 350 miles. The tracks include numerous crustacean foot-prints and the trails of worms. The vertebrate tracks consist in part of small groups of four-toed so-called "amphibian" prints, which lack a heel-pad; in part, doubtfully, of oval impressions with a finely corrugated surface, as if due to the impress of a skin-covered "hoof-like" foot; and in part of a series of peculiar parallel sinuous lines, possibly made by ventral spines of a fish armed after the fashion of the Carboniferous and Permian Acanthodes.—J. H. Power: Notes on the habits and life-histories

of certain little-known Anura with descriptions of the tadpoles *Cassina Senegalensis*, *Phrynomantis bifasciata*, and *Bufo cavens*, collected by Lobatsi, are described. The tadpole of *Cassina* was observed to devour mosquito eggs—F. von Huene. Some additions to the knowledge of *Procolophon*, *Lystrosaurus*, *Noteosuchus*, and *Cistecephalus*. An impression of the skin surrounding the parietal foramen of a specimen of *Procolophon* shows small polygonal pits bounded by thick meandering walls. The large parietal foramen possibly contained a functional organ. The skull of *Lystrosaurus* contains a transverse bone (ectopterygoid) in the same position as in *Dicynodon*—K. H. Barnard. Report on a collection of Crustacea from Portuguese East Africa. The present collection contains 57 species, of which 14 have been previously recorded. The capture of a crayfish of the genus *Palinustus*, hitherto known only from the West Indies, and of three Indo-Pacific forms not reported since their discovery by the *Challenger*, are the most striking results. Two new varieties and two new species are described.—J. Groves and Edith L. Stephens: New and noteworthy S.A. Charophyta. South Africa is rich in endemic types belonging to the group, some of them of outstanding beauty and interest, and this paper describes six of these new species—W. J. Hodgetts: Contributions to our knowledge of the freshwater algae of Africa. No. 6. Some freshwater algae from Stellenbosch. 184 species are recorded, and nine species, eight varieties, and several forms are described as new. The most striking feature of the collection is the relatively large number (53) of species of desmids, a group rather scantily represented in collections from other parts of South Africa.—F. G. Cawston: Some observations of the radulae of freshwater Mollusca. The cones and cusp-formation of the radulae of freshwater mollusca which serve as intermediate hosts for Trematoda in South Africa are described.

ROME.

Royal Academy of the Lincei, May 2—Guido Fubini. Varieties with collinear plane sections.—Gino Fani: The surfaces of space S_3 with collinear plane sections.—S. Pincherle. Certain functional transformations.—Leonida Tonelli: Green's theorem.—M. La Rosa. Experimental foundations of the ballistic principle applied to the velocity of light.—M. Cisotti: Dynamic effect of a current flowing between a cylinder and an undefined plane wall.—O. M. Corbino and E. Persico: Influence of a magnetic field on the action of a three-electrode lamp.—Luigi Fantappiè: Linear analytic functionals and their singularity.—Luigi Fantappiè: The derivation of analytic functionals.—S. Finikoff. The principal surfaces of Bianchi's rectilinear congruences.—Letterio Labocchetta. Analytic representation in finite form of the functions the diagrams of which consist of a succession of arcs of different lines varying according to a definite law from one interval to the next.—D. J. Struik. Rigorous determination of the periodic irrotational waves in a channel.—R. Serini. Capacity of the electric condenser with infinitely thin circular plates.—F. De Carl: The capacity for reaction in the solid state of anhydrides and metallic oxides. The reactivity of anhydrides with metallic oxides in the solid condition is general and varies with the nature of the reacting oxides, being most marked with oxides of the alkaline earth metals and also with boric, molybdic, tungstic, vanadic, and silicic anhydrides.—Emilio Oddone. Alterations caused in isobaric configurations by

calming of the air.—G. Brunelli: Autotomy of the posterior lobe of the vitellin sac in *Salmo salar*, L.—Silvio Ranzi. An organ of sense derived from the first epibranchial placoid of *Selachii*.—Filippo Eredia. Forecast of the almond crop of any season on the basis of the air temperature and rainfall in the three months January to March inclusive.—Primo Dorello. The functions of the peduncle, diverticulum, and Swammerdam's vesicula in the genus *Helix*.

May 17.—Guido Fubini. An observation of the transcendent δ (π) of Pincherle—Francesco Severi: Theory of the correspondence between algebraic curves.—U. Cisotti: Dynamic effect of a current circulating round a cylinder in a tunnel.—Fil. Bottazzi and L. De Caro: Variations produced in the electrical resistance of the muscles by various physical and chemical agents. The results are given of investigations on the influence of temperature on the electrical resistance of muscle and essentially connective membranes, and on the isoelectric point of muscular colloids.—Seb. Timpanaro. Experiments on floating laminae.—G. Scagliarini: Additive compounds of stannic iodide and organic bases.—P. Comucci. Azurite from Pistello (Elba).—G. Brunelli: Significance of the oily drops in the egg of Teleostei and location of the oxidases.—G. Amantea: Investigations on the spermatid secretion. xvi. Collection of the sperm and elimination of the spermatozoa of the pigeon.—Umberto D'Ancona: Double innervation of the muscles of the decapod crustaceans.—V. De Laurenzi: Parotid secretion in man caused by various peripheral factors.—Nazzareno Grisogani: Rhythm of the parotid secretion in man, and gustatory and olfactory sensations.—Cesare Artom: Abnormal segmentation at the commencement of development in the egg of *Cagliari's Artemia salina diploide*.

SYDNEY.

Linnean Society of New South Wales, April 29.—G. H. Hardy: Australian Mydidae (Diptera). A descriptive and synonymic catalogue of the dipterous family Mydidae, containing two genera and nine described species recognised as valid.—J. R. Malloch: Notes on Australian Diptera, No. v. Keys are presented for the recognition of the genera of Muscidae known from Australia, together with a key for the species of Helina, of which four are described as new.—F. G. Clapp: A few observations on the geology and geography of North-west and Desert Basins, Western Australia.—A. H. K. Petrie: An ecological study of the flora of Mount Wilson, Part II. The Eucalyptus forests. The Eucalyptus forests form the main plant-covering of the sandstone plateau, and also occur on the outskirts of the basalt residuals. Discussing the ecology of Eucalyptus forests, special reference is made to their relation to fires. Further observations are also recorded on the stratum-societies of the junction flora, with a special discussion of the status of the Pteridium society.

Royal Society of New South Wales, May 6.—C. Anderson. The Australian fauna (Presidential address). The fauna has often been described as the most interesting and important in the world. Australia became separated from other continental masses in late Cretaceous or very early Tertiary times, and, protected by their isolation from the competition of later and higher forms, the animals of Australia are in many instances archaic survivals, which are closely related to forms long since extinct.

in other lands. The dispute as to the route whereby the marsupials and other forms entered Australia will probably be settled only by further discoveries, particularly in palæontology.

VIENNA.

Academy of Sciences, May 7.—Ph. Furtwängler: On minimal bases for bodies of rational functions.—F. Hemmelmayr and T. Meyer: The influence of various substitutes on the tenacity of the carboxyl group in substituted aromatic acids, the influence of a second carboxyl group and the relative activity of chlorine and bromine.—C. Diener: Geological investigations on the Milbrunnkogel near Aussee in Styria.—A. Blumenstock: On the preparation of stearylacton.—J. Lindner and A. Siegel: The course of the chinaldin synthesis in the tetralylamines, 7, 8-tetra-methylen-chinaldin.—J. Lindner and M. Staufer: The course of chinaldin synthesis in β -amino-tetralin.—G. Weissenberger, F. Schuster, and H. Pamer: On organic molecular compounds. (xiii.) Studies on the calculation of vapour pressure curves.—K. Mayrhofer: Representation of a complex of rays by a dual quadratic differential form.

WASHINGTON, D.C.

National Academy of Sciences (Proc., Vol. 11, No. 5, May).—W. C. Boeck and J. Drbohlav: The cultivation of *Endameba histolytica*. An organism from human faeces, which agrees with *E. histolytica* in movements, nutrition, morphology, and pathogenicity, has been cultivated on Locke egg-serum and Locke egg-albumin. *E. histolytica* in culture feeds on bacteria and blood corpuscles, if they are present. The cultured organisms were as pathogenic to kittens as fresh material.—S. F. Chiang: The rat as a possible carrier of the dysentery amoeba. Rats can be infected with *E. histolytica* of human origin by feeding material containing cysts. Infection is transmitted readily from rat to rat by association in the same cage, and may persist for four months. Apparent varieties of *E. histolytica* occur spontaneously in laboratory rats. The rat may therefore be a possible carrier of the causal organism of amoebic dysentery.—L. P. Eisenhart: Linear connexions of a space which are determined by simply transitive continuous groups.—J. W. Alexander: Note on a theorem by H. Kneser.—L. Ingold: Associated types of linear connexion.—J. M. Thomas: Conformal correspondence of Riemann spaces.—C. Barus: Pinhole probe measurements of the phase change of the telephonic end plates, acting on a closed cylindrical air column in longitudinal acoustic vibration.—E. B. Wilson: On the Boltzmann equation $\rho = \rho_0 \exp. (-w/kt)$.—H. Kahler: The band spectra of crystals and complex gases.—E. B. Wilson and W. J. Luyten: The frequency distribution of some measured parallaxes and of the parallaxes themselves. 313 determinations of parallaxes of stars between magnitudes 5 and 6 were used. On probability paper, the distribution gives a straight line within the errors of sampling. Graphs are given of the frequency distribution on a parallax base.—E. W. Brown: The effect of varying mass on a binary system. If rate of change of momentum equals force, angular momentum remains constant while a real velocity increases, and, unless the two masses are equal, the velocity of the centre of mass increases. The hypothesis thus provides for increase of velocity of the star with age (Russell's scheme of evolution) and the velocity of a single star relative to the centre of mass of the whole stellar system will decrease.

Official Publications Received.

- Joint Board of Research for Mental Diseases: City and University of Birmingham. Annual Report of the Laboratory for Year ending March 1925. Pp. 11. (Birmingham.)
- Papers from the Geological Department, Glasgow University. Vol. 7, 1924. Pp. iv+302. (Glasgow: Jackson, Wylie and Co.)
- Proceedings of the American Academy of Arts and Sciences. Vol. 60, No. 1: The Geology of Ascension Island. By Reginald A. Daly. Pp. 80+21 plates (Boston, Mass.) 3 dollars.
- University College of South Wales and Monmouthshire: Faculty of Science. Information regarding Courses and Careers open to Students of Science. Pp. 22. (Cardiff.)
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Oil in Navigable Waters.

IN a recent publication ("Oil in Navigable Waters," H.M.S.O., 1925, 6d.) the Board of Trade has made a valuable contribution to the problem of abating the pollution of the sea by oil. The inquiries made by the engineering staff show that those ships which carry fuel oil in bulk and use their oil tanks for water ballast are the most likely to cause pollution at present, and in the near future. In these cases a large bulk of water is mixed with oil, and is separable from the oil only with difficulty and uneconomically. It is considered that separators can now be designed to deal with any ordinary mixture of oil and water so efficiently that the water discharged from this mixture into the sea is sufficiently free from oil to be innocuous, and the provisions of the Oil in Navigable Waters Act of 1922 are ensuring that oil-free water from such mixtures is being pumped into the sea at least within the three-mile limit. Nevertheless, if the shores of Britain are to be kept free from oil, it will be necessary to extend the limit to a much greater distance than three miles to restrict the pollution to that oil, which, Lord Bearsted has pointed out in the *Times*, may be escaping from vessels sunk during the War.

It is known (see Orton, *NATURE*, vol. 90, 1913, p. 700) that continuous strong south-westerly winds will blow the Portuguese Man-of-War (*Physalia*) and Velella from the sub-tropical Atlantic regions up the Channel on to the southern shores of England, over a distance which must be reckoned at least in several half-hundreds of miles; hence there can be no doubt that continuous strong inshore winds may blow oil from deep water on to the shores, notwithstanding tidal currents. It is also apparent that oil discharged in an estuary outside the three-mile limit, but on an incoming tide, may easily result in an accumulation of oil on the shore.

With regard to this aspect of the problem, Mr. A. W. Bibby has recently pointed out that British merchant ships would be at a still greater disadvantage in comparison with foreign ships, if the limit were extended and applicable only to British ships, and that, therefore, we must look to an international agreement to extend the distance within which oil may not be discharged at sea, say, to ten miles off-shore, to give greater protection to the shore. There are signs that the sensitiveness of nations with regard to any alteration of the territorial three-mile limit is breaking down in the recent Anglo-American agreement to permit examination of British vessels inside a ten-mile limit from the American coast. The influential body comprising the American National Coast Anti-Pollution League—which has passed a resolution "that the dumping of oil waste and refuse is ruining the bathing beaches

situated on the territorial waters of the various countries, that the pollution takes place on high seas as well as territorial waters; that the President of the United States was authorised and requested to call a Conference of Maritime Nations with a view to adopting effective means for the prevention of the pollution of navigable waters"—is also apparently ready to approve an agreement giving greater protection to all shores.

The inquiries made by the Board of Trade brought from local and harbour authorities, coastguards, sea fisheries committees, and district inspectors of fisheries, numerous observations on the deplorable destruction of sea-birds from contact with oil, cases of damage to paintwork of boats, piers, and other permanent structures; risk of fire in enclosed waters, and a variety of opinion on the effect of oil on "fish" life. With regard to opinions on the effect of oil on marine organisms, they are mainly uncritical, but the statement by the North-eastern Sea Fisheries Committee that "crabs, lobsters, shrimps, and prawns are quickly smothered and killed by oil," is worth substantiation, as is also that made by more than one body that oil causes fishing-nets to rot very quickly. There is a general agreement in the replies that pollution has decreased markedly in most areas since the introduction of the Oil in Navigable Waters Act, 1922.

Among the general public there is, fortunately, much interest in problems connected with the loss of oil at sea, and many valuable observations have been made in the Press. Lord Rayleigh has calculated that half-a-million tons of oil could cover the whole ocean with a film, but has not postulated the conditions in which it would do so. Prof. H. E. Armstrong has stated that a film of oil would not deprive marine life of oxygen or light, but might react on that life in an insidious but undefined manner. It has been pointed out that oil bubbles into the Caspian Sea in a perpetual stream, but that although fishing is poor in the locality of the escaping oil, there is heavy fishing in neighbouring parts of that sea, and other writers have observed that oil which has risen to the surface of water in oil-bearing regions, has after a short time sunk again after the evaporation of the lighter constituents. The latter observations are hopeful in considering the fate of floating masses of oil, and are well worth further investigation.

The sum of the information now available on these problems is useful, but might be made still more valuable if followed up by an enumeration and chemical examination of (1) the different kinds of fuel oils, and (2) the waste oils actually discharged from the bilges or tanks of oil-burning vessels. A certain amount of data on these matters exists, but a departmental investigation would collect and place on record together just that kind of information we at present lack.

Primitive Law.

Primitive Law. By E. Sidney Hartland. Pp vi+222. (London: Methuen and Co., Ltd., 1924) 7s. 6d. net.

ANTHROPOLOGY is to most laymen and to many specialists still mainly an object of antiquarian interest. There are, however, certain aspects of it which are of a genuine scientific character, in that they do not lead us beyond empirical fact into realms of uncontrollable conjecture, in that they widen our knowledge of human nature, and in that they are of a direct practical application. I mean such a subject, for example, as primitive economics, important for our knowledge of man's economic dispositions and of value to those who wish to develop the resources of tropical countries, employ indigenous labour and trade with the natives. Or again a subject such as the comparative study of the mental processes of savages, a line of research which has already proved fertile to psychology and might be made useful to those engaged in educating or morally improving the native. Last, but not least, there is the subject of primitive law, the study of the various forces which make for order, uniformity and cohesion in a savage tribe. The knowledge of these forces should have formed the foundation of anthropological theories of primitive organisation and it should have yielded the guiding principles of Colonial legislation and administration. Yet of all branches of anthropology, primitive jurisprudence has received in recent times the scantiest and the least satisfactory treatment. This is the reason why the present book by Mr. Sidney Hartland deserves special attention, devoted as it is exclusively to the discussion of primitive law and written by one who is both a learned anthropologist and a professional lawyer.

Anthropology has not always been so indifferent about savage justice and the methods of its administration as it is at present. About half a century ago there was a positive epidemic of research into primitive law, especially on the Continent, more particularly in Germany. It is enough to mention the names of Bachofen, Post, Bernhoff, Kohler and the other writers grouped round the *Zeitschrift für vergleichende Rechtswissenschaft*, to remind the sociologist of the scope, volume and quality of the work done by them. This work, however, was heavily handicapped. The writers had to rely upon the data of the early amateur ethnographers—modern field-work of the trained specialist, done with method, purpose and knowledge of the problems, was at that time not yet in existence. In an abstract and complex subject, such as primitive law, amateur observations are, on the whole, useless.

The early German students of savage law again were all and one committed to the hypotheses of "primitive

promiscuity" and "group-marriage," just as their British contemporary, Sir Henry Maine, was handicapped by his too narrow adhesion to the patriarchal scheme. Most of these continental efforts in anthropological jurisprudence were directed to—in fact, wasted upon—the task of proving that Morgan's theories are correct. The myth of "group-marriage" was casting its shadow on all their arguments and descriptions and it infected their juridical constructions with the kindred concepts of "group-responsibility," "group-justice," "group-property," and "communism," in short, with the dogma of the absence of individual rights and liabilities among savages.

Underlying all these ideas was the assumption that in primitive societies the individual is completely dominated by the group—the horde, the clan or the tribe—that he obeys the commands of his community, its traditions, its public opinion, its decrees, with a slavish, fascinated, passive obedience. This assumption, which gives the leading tone to most modern discussions upon the mentality and sociality of savages, in the French school of Durkheim, in most American and German works and in some English writings, has survived, as we shall see, right into the present work of Mr Sidney Hartland.

Thus handicapped by insufficient material and baseless assumptions, the early school of anthropological jurisprudence was driven into an impasse of artificial and sterile constructions. In consequence it proved incapable of real vitality, and the whole interest and work heavily slumped—in fact, almost entirely subsided—after its first short-lived boom. One or two important books on the subject appeared—Steinmetz's inquiries into the beginnings of punishment, Durkheim's analysis of early criminal and civil law—but on the whole, the first impetus has proved so little inspiring that most modern anthropologists, both in theory and in field-work, ignore its very existence. In the standard manual "Notes and Queries on Anthropology," "law" appears neither in the index nor in the table of contents, and the few lines devoted to it under the heading of "Government: Politics," excellent as they are, do not correspond in any way to the importance of the subject. In the book of the late Dr. Rivers on "Social Organisation" the problem of primitive law is discussed only incidentally, and, as we shall see, it is rather banished from primitive sociology than included in it by the author's brief reference to it.

This lacuna in modern anthropology is due, not to any oversight of primitive legality, but on the contrary to its over-emphasis. Paradoxical as it sounds, it is yet true that present-day anthropology neglects primitive law just because it has an exaggerated, and I will add at once a mistaken, idea of its perfection. Thus we

read in the present book the following sentences: "The savage is far from being the free, and unfettered creature of Rousseau's imagination. On the contrary, he is hemmed in on every side by the customs of his people, he is bound in the chains of immemorial tradition not merely in his social relations, but in his religion, his medicine, in his industry, his art: in short, every aspect of his life" (p. 138). With all this we might agree, except that it seems doubtful whether the "chains of tradition" are identical or even similar in art and in social relations, in industry and in religion. But when, immediately, we are told that "these fetters are accepted by him (the savage) as a matter of course; he never seeks to break forth"—we must enter a protest. Is it not contrary to human nature to accept any constraint as a matter of course, and does man, whether civilised or savage, ever carry out unpleasant, burdensome, cruel regulations and taboos without being compelled to? And compelled by some force or motive which he cannot resist?

Yet this automatic acquiescence, this instinctive submission of every member of the tribe to its laws, is the fundamental axiom laid at the basis of the inquiry into primitive order and adherence to rule. Thus another foremost authority on the subject, the late Dr. Rivers, speaks in the book already mentioned of an "unwitting or intuitive method of regulating social life," which is, according to him, "closely connected with primitive communism." And he proceeds to tell us: "Among such peoples as the Melanesians there is a group sentiment which makes unnecessary any definite social machinery for the exertion of authority, in just the same manner as it makes possible the harmonious working of a communal ownership and insures the peaceful character of a communistic system of sexual relation" ("Social Organisation," p. 169).

Thus here again we are assured that "unwitting" or "intuitive methods," "instinctive submission" and some mysterious "group-sentiment" account for law, order, communism and sexual promiscuity alike! This sounds altogether like a Bolshevik paradise, but is certainly not correct in reference to Melanesian societies, which I know at first hand.

A similar idea is expressed by a third writer, who has contributed towards our understanding of the organisation of savages from the point of view of mental and social evolution more perhaps than any one living anthropologist. Prof. Hobhouse, speaking of the tribes on a very low level of culture, affirms that "such societies, of course, have their customs, which are doubtless felt as binding by their members, but if we mean by law a body of rules enforced by an authority independent of personal ties of kinship and friendship, such an institution is not compatible with their social

organisation" ("Morals in Evolution," 1915, p. 73). Here we have to question the phrase "felt as binding" and ask whether it does not cover and hide the real problem instead of solving it. Is there, with regard to some rules at least, no binding mechanism, not perhaps enforced by any central authority, but backed up by real motives, interests and complex sentiments? Can severe prohibitions, onerous duties, very burdensome and galling liabilities, be made binding by a mere "feeling"? We should like to know more about this invaluable mental attitude at least, but the author simply takes it for granted. Again, the minimum definition of law as the "body of rules, enforced by an authority independent of personal ties," seems to me to be too narrow and not to lay the emphasis on the relevant elements. There are among the many norms of conduct in savage societies certain rules regarded as compulsory obligations of one individual or group towards another individual or group. The fulfilment of such obligations is usually rewarded according to the measure of its perfection, while non-compliance is visited upon the remiss agent. Starting with such a comprehensive view of law and inquiring into the nature of the forces which make it obligatory, it is possible to arrive at much more satisfactory results than taking the question of authority, government and punishment for starting points.

To take another representative opinion of one of the highest anthropological authorities in the United States, we find Dr. Lowie expressing a very similar view: "Generally speaking, the unwritten laws of customary usage are obeyed far more willingly than our written codes, or rather they are obeyed spontaneously" ("Primitive Society," chap. on "Justice," p. 387, English Edition). To compare the "willingness" in obedience to law of an Australian savage with a New Yorker, or of a Melanesian with a nonconformist citizen of Glasgow, is a perilous proceeding and its results have to be taken very "generally" indeed, until they lose all meaning. The fact is that no society can work in an efficient manner unless laws are obeyed "willingly" and "spontaneously." The threat of coercion and the fear of punishment do not touch the average man, whether "savage" or "civilised," while, on the other hand, they are indispensable with regard to certain turbulent or criminal elements in either society. Again, there is a number of laws, taboos and obligations in every human culture which weigh heavily on every citizen, demand great self-sacrifice, and are obeyed for moral, sentimental or matter-of-fact reasons, but without any "spontaneity."

It would be easy to multiply statements and to show that the dogma of the automatic submission to custom dominates the whole inquiry into primitive law.

Now with this dogma of automatic obedience there are associated certain more special propositions which are universally current in anthropology and yet fatal to the study of primitive jurisprudence.

First of all, if all the rules of custom are obeyed by the savage through sheer inability to break them, then no definition can be given of law, no distinction can be drawn between the rules of law, morals, manners, and other usages. For the only way in which we can classify rules of conduct is by reference to the motives and sanctions by which they are enforced. So that with the assumption of an automatic obedience to all custom, anthropology has to give up any attempt at introducing into the facts order and classification, which is the first task of science.

We have seen already that Mr. Sidney Hartland regards the rules of art, medicine, social organisation, industry and what-not as hopelessly mixed up and lumped together in all savage societies, both in the native's own comprehension and in the reality of social life. He states this view emphatically on several occasions: "... The savage's perception of resemblances differs very much from our own. He sees resemblances between objects which, to our eyes, have not a single point in common" (p. 139). "For the savage . . . the policy of a tribe is one and indivisible. . . . They [the savages] see nothing grotesque or incongruous in publishing in the name of God a code combining ritual, moral, agricultural, and medical with what we understand as strictly juridical prescriptions. . . . We may sever religion from magic, and magic from medicine; the members of the community draw no such distinctions" (pp. 213, 214).

In all this Mr. Sidney Hartland gives lucid and moderate expression to the current views about "primitive prelogical mentality," "confused savage categories," and the general shapelessness of early culture. These views, however, in my opinion, cover but one side of the case, express but a half-truth—as regards law, the views here quoted are not correct. The savages have a class of obligatory rules, not endowed with any mystical character, not set forth in "the name of God," not enforced by any supernatural sanction, but provided with a purely social binding force. The author of "Primitive Law" and most sociologists who share his opinions are not to blame for neglecting these facts of early jurisprudence, for the field-workers have never supplied them with the adequate and relevant material.

In the second place, the dogma of the absolute rigidity of the rules of custom implies an extraordinary over-emphasis of criminal law in primitive communities and a corresponding denial of the possibility of civil law. Absolutely rigid rules cannot be stretched or

adapted to life, they need not be enforced—but they can be broken. So much even the believers in a primitive super-legality must admit. Hence crime is the only legal problem to be studied in primitive communities, there is no civil law among savages, nor any civil jurisprudence for anthropology to work out. This view has dominated comparative studies of law from Sir Henry Maine to the most recent authorities, such as Prof. Hobhouse, Dr. Lowie and Mr. Sidney Hartland. Thus we read in the book under review that in primitive societies “the core of legislation is a series of taboos,” and that “almost all early codes consist of prohibitions” (p. 214). The doctrine that primitive norms of conduct are negative, rigid and religious in character pervades all the book. In this again Mr. Hartland is not alone. Steinmetz in his learned and competent analysis of primitive punishment insists on the criminal character of early jurisprudence, on the mechanical, rigid, almost undirected and unintentional nature of the penalties inflicted and on their religious basis. His views are fully endorsed by the great French sociologists Durkheim and Mauss, who add besides one more clause: that responsibility, revenge, in fact all legal reactions are founded in the psychology of the group and not of the individual.¹ Even such acute and well-informed sociologists as Prof. Hobhouse and Dr. Lowie, the latter acquainted at first hand with savages, seem to follow the trend of the general bias in their otherwise excellent chapters on justice in primitive societies.

Here again, I think that it would be futile to blame these writers, who have treated the material available with all the necessary acumen and the soundest scientific methods. It would be also unfair to blame the trained field-worker—often approaching anthropology from natural science or medicine—for his failure to grasp one of the most difficult and slippery problems of primitive sociology. I believe, however, that there is a mine of facts still to be worked out in savage communities, which will, when available, force us to recast all current conclusions. Primitive law is by no means negative only or even predominantly. The positive rules of conduct, the obligations to do, to fulfil are innumerable. They are not based on merely religious sanctions, nor is the “group” the focus of all legal forces.

In my own studies in north-west Melanesia I have found that human nature always rebels against the rigid letter of the law, that the individual will always stretch the rule or try to evade it—and all this while remaining on the “right side of the law,” that is, taking good care not actually to break it. Not only that; such attempts are often helped out, abetted by

what could be called customary ways of infringement of the law, semi-legalised methods of evasion. So that in reality the “cake of custom” is not a uniform crust, evenly pressing its contents, nor is human nature mere dough, which would passively submit to such pressure.

The natives will defy law at times, but much more readily they will try to circumvent it. The fear or awe of infringing their customs is a figment. We read in Mr. Hartland's book that “the general belief in the certainty of supernatural punishment and the alienation of the sympathy of one's fellows generate an *atmosphere of terror* which is quite sufficient to prevent a breach of tribal customs . . .” (p. 8—the italics are mine). There is no such “atmosphere of terror” unless perhaps in the case of a few very exceptional and sacred rules of ritual and religion, and on the other hand the breach of tribal customs is prevented by a special machinery, the study of which is the real field of primitive jurisprudence. In this, as everywhere else, it would be easy to show that Mr. Hartland is not to blame for his opinion, but that he has given us a clear and judicious summary of the data available from the best records of field-work.

Finally, the fundamental assumption of the rigidity of custom and the savage's automatic compliance with law implies yet one more consequence. It renders quite superfluous any attempt at an analysis of the processes of the adjustment of law to life. If all custom is always obeyed, and obeyed strictly and automatically, then there is no need to study how the formula of law is being adapted to concrete circumstances. All the questions of the latitude, of the laws, of the elasticity of its binding forces of the various readjustments and legal compromises must appear to the writers of anthropological jurisprudence as non-existent.

To sum up briefly the present state of primitive jurisprudence: it is being universally assumed that all custom is law to the savage and that he has no law but his custom. All custom again is obeyed automatically and rigidly by sheer inertia. There is no civil law or its equivalent in savage societies. The only relevant facts are the occasional breaches in defiance of custom—the crimes. There is no mechanism of enforcement of the primitive rules of conduct except the punishment of flagrant crime. Modern anthropology, therefore, ignores and, sometimes even explicitly denies the existence of any social arrangements or of any psychological motives which make primitive man obey a certain class of custom for purely social reasons. According to Mr. Hartland and all the other authorities, religious sanctions, supernatural penalties, group responsibility and solidarity, taboo and magic are the main elements of jurisprudence in savagery.

¹ Steinmetz, “Ethnologische Studien zur ersten Entwicklung der Strafe,” 1894; Durkheim in *Année Sociologique*, 1. pp. 353 sqq.; Mauss in “Revue de l'Histoire des Religions,” 1897.

All these contentions are, as I have already indicated, either directly mistaken, or only partially true, or, at least, they can be said to place the reality of native life in a false perspective. Perhaps there is no further need to argue that no man, however "savage" or "primitive," will *instinctively* act against his instincts, or *unwittingly* obey a rule which he feels inclined cunningly to evade or wilfully to defy; or that he will not *spontaneously* act in a manner contrary to all his appetites and inclinations. The fundamental function of law is to curb certain natural propensities, to hem in and control human instincts and to impose a non-spontaneous, compulsory behaviour—in other words, to ensure a type of co-operation which is based on mutual concessions and sacrifices for a common end. A new force, different from the innate, spontaneous endowment must be present to perform this task.

In order to make this negative criticism conclusive, however, it is necessary to add a positive statement of the case, to present the facts of primitive law as it really is, to show in what consists the compulsory nature of primitive legal rules, to lay bare the specific force which makes them into binding law.

The Melanesian of the region which I have studied has unquestionably the greatest respect for his tribal custom and tradition as such. This much may be stated at the outset. All the rules of his tribe, trivial or important, pleasant or irksome, moral or utilitarian, are regarded by him with reverence and felt to be obligatory. But the force of custom, the glamour of tradition, if it stood alone, would not be enough to counteract the temptations of appetite or lust or the dictates of self-interest. Custom is sufficient to carry through the rules of good manner, the rules of order in most situations of daily life or on public occasions—so long as no strong appetite or interest has to be countered. Thus the mere sanction of tradition—the conformism and conservatism of the "savage"—operates often and operates alone in enforcing manners, customary usage, private and public behaviour in all cases where some rules are necessary to establish the mechanism of common life and co-operation and to allow of orderly proceedings—but where there is no need to encroach on self-interest, inertia or to prod into unpleasant action or thwart innate propensities.

There are other rules, dictates and imperatives which require and possess their special type of sanction, besides the mere glamour of tradition. The natives in that part of Melanesia have to conform to a very exacting type of religious ritual, especially at burial and in mourning, and this behaviour is enforced by the special constraint of religious awe and certain definite supernatural and social penalties. There are, again, imperatives of behaviour between parents and children,

husband and wife, backed mainly by the natural sentiment of love and affection. There are the rules of art and craft, followed for motives of utility, besides the reverence for tradition. There exists finally the sanction of tribal punishment, due to a reaction in anger and indignation of the whole community. By this sanction human life, property, and, last though not least, personal honour are safeguarded in a Melanesian community, as well as such institutions as chieftainship, exogamy, rank and marriage, which play a paramount part in their tribal constitution.

Each class of rules just enumerated is distinguishable from the rest by its sanctions and by its relation to the social organisation of the tribe and to its culture. They do not form this amorphous mass of tribal usage or "cake of custom" of which we have been hearing so much. The last category, the fundamental rules safeguarding life, property and personality form the class which might be described as "criminal law"—very often over-emphasised by anthropologists and falsely connected with the problem of "government" and "central authority" and invariably torn out of its proper context of other legal rules. For—and here we come at last to the most important point—there exists a class of binding rules which control most aspects of tribal life, which regulate personal relations between kinsmen, clansmen and tribesmen, settle economic relations, the exercise of power and of magic, the status of husband and wife and of their respective families. These are the rules of a Melanesian community which correspond to our civil law.

There is no religious sanction to these rules, no fear, superstitious or rational, enforces them, no tribal punishment visits their breach, nor even the stigma of public opinion or moral blame. The forces which make these rules binding we shall lay bare and find them not simple but clearly definable, not to be described by one word or one concept, but very real none the less. The binding forces of Melanesian civil law are to be found in the concatenation of the obligations, in the fact that they are arranged into chains of mutual services, a give and take extending over long periods of time and covering wide aspects of interest and activity. To this there is added the conspicuous and ceremonial manner in which most of the legal obligations have to be discharged. This binds people by an appeal to their vanity and self-regard, to their love of self-enhancement by display. Thus the binding force of these rules is due to the natural mental trends of self-interest, ambition and vanity, set into play by a special social mechanism into which the obligatory actions are framed.

It is quite clear, I trust, that none of the criticism of this review is levelled against Mr. Sidney Hartland's

own contributions to the problem. His book is not only a most learned and brilliant achievement; it comes also most useful and handy in the present state of our knowledge, for it is a veritable masterpiece of lucid, competent, thorough synthesis of past and contemporary researches and theories of primitive law. Mr. Sidney Hartland is one of the great representatives of the comparative school of anthropology, and, like some other writers of this school, he has been able to vindicate the claims of anthropology to be a genuine science in that he foretold discoveries not yet made at that time. In his *Legend of Perseus* and his subsequent work of first-class value he has given new and most illuminating contributions to the study of primitive kinship. His "forecast of primeval past," as we might call it perhaps, about the primitive ignorance of paternity has been proved in the discoveries of Spencer and Gillen in Australia, and of the present reviewer in Melanesia. His new work deserves to rank among the best recent contributions to anthropology: it should be read by all those students who recognise that our science has not done justice to the study of primitive law and by all the observers of savage races who wish to work out what will prove, perhaps, the most fertile plot of their field.

B. MALINOWSKI.

The Metaphysic of Science.

The Metaphysical Foundations of Modern Physical Science: a Historical and Critical Essay. By Prof. Edwin Arthur Burtt. (International Library of Psychology, Philosophy and Scientific Method.) Pp. ix + 349. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1925.) 14s. net.

PROF. BURTT has given us a study of the history of modern science from an unusual but very important point of view. He has sought to lay bare the principle underlying and directing scientific discovery rather than to chronicle the discoveries in their objective and practical aspect. He finds that the metaphysic of science when it is laid bare is neither self-evident nor consistent, but in fact highly paradoxical. In his concluding chapter he invites men of science and philosophers to study this metaphysic critically with a view to its fundamental reformation. It is the metaphysics of Newton:

"Wherever was taught as truth the universal formula of gravitation, there was also insinuated as a nimbus of surrounding belief that man is but the puny and local spectator, nay irrelevant product of an infinite self-moving engine, which existed eternally before him and will be eternally after him, enshrining the rigour of mathematical relationships while banishing into impotence all ideal imaginations; an engine

which consists of raw masses wandering to no purpose in an undiscoverable time and space, and is in general wholly devoid of any qualities that might spell satisfaction for the major interests of human nature, save solely the central aim of the mathematical physicist."

It is a curious thing that Newton, whose fame in the first half of the eighteenth century as the representative English philosopher resounded throughout the learned world, finds no place in any of the standard histories of philosophy. Voltaire's "*Éléments de la philosophie de Newton*" was not only widely read but also chiefly instrumental in dethroning the Cartesians and Leibnizians and preparing the stage for empiricism, positivism, and scientific realism. Neither by ourselves nor by others, however, is Newton now placed in the line of the historical philosophical development; he is always ranked as a pioneer of science, deriving his lineage from Copernicus, Galileo, and Kepler. Yet to his contemporaries, to Leibniz, Locke, and Berkeley, he was primarily a metaphysician, and to Kant in the later eighteenth century Newton's concepts of space and time set the task of the transcendental æsthetic.

It is only in recent times, in fact since the nineteenth century advance of the physical sciences, that the history of thought has undergone retrospectively a bifurcation into science and philosophy. The ground or reason of the separation, and for placing Newton in the line of science as opposed to the line of philosophy, was largely the consequence of Newton's own attitude towards physical problems. To emphasise the value of experiments he seemed to decry the method of logical deduction and the appeal to the criterion of consistency. His "physics beware metaphysics" and his "hypotheses non fingo" were everywhere quoted to deprecate philosophical speculation. Then, in opposition to this provocative attitude to philosophy, Hegel was aroused to his contemptible reference to the use of the term "philosophical" which the English, he said, employed to describe scientific instruments. There is a great change in our thought to-day. We are discovering that the divorce between physics and metaphysics is not only irrational but also disastrous, alike in the interests of philosophy and science.

Prof. Burtt brings out in a very striking way the interesting contrast between the mathematical principle which underlay the philosophy of Descartes and his followers in France and the physical principle which predominated in all the seventeenth-century philosophies in England. There was, however, one important thing common to both lines and to both principles. In whatever way philosophers conceived the absolute in Nature, whether as a mathematical or as a physical principle, whether under the form of extension or under the form of ether, it was

never conceived abstractly, for it was always correlated with the concept of God. For example, Newton's absolute space and time are God's sensorium, Berkeley's absolute *esse* is God's *percipi*. Now the absolute of modern science, the real world of physics, is, on the other hand, the concept of an abstract reality, conceived as existing in itself even if there be no God and whether there be one or not. It is this abstract absolute which has been tried and found wanting by the contemporary relativists. The principle of relativity tells us that there is no world which is no one's world, no space-time which is not some one's space-time. The space-time and the ether which are the common world, the world to which our mathematical equations and our physical concepts apply, are a function of the intercourse of observers of Nature co-ordinating their universe each from the point of view of his own system chosen as a frame of reference. It is impossible to visualise the ultimate reality of physics because it does not originate in a sensible image but in a mathematical formulation. It is by active measurements that the reality of physics is provided to science.

Prof. Burt concludes his most instructive historical and critical review by exposing the extraordinary difficulties of the epistemological theory based on the Cartesian dualism of mind and body, a dualism which in one form or another has persisted throughout the modern period.

H. WILDON CARR.

An American View of the Agricultural Situation.

The Agricultural Situation: Economic Effects of Fluctuating Prices. By Prof. G. F. Warren and Prof. E. A. Pearson. (The Price-Series.) Pp. xvi + 306. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 15s. net.

TO many in Great Britain it will come as somewhat of a surprise to learn that the American farmer finds almost as much difficulty as the British farmer in making both ends meet: indeed, so far as comparisons are possible, he seems to be in a worse plight. There are no better qualified men on this subject than Profs. Warren and Pearson, and they give in this book a very clear exposition of the situation, but the picture is far from rosy and the authors close on a pessimistic note: they see no easy way out of the difficulty.

The trouble arises from the low price received by the farmer for his products in comparison with the high price he has to pay for services and materials received. It required twice as much farm produce to pay the taxes, interest charges, and labour in 1922 as it did before the War. Labour has unfortunately not become

more efficient, and farm production has not increased. There are two obvious remedies: farmers might combine and obtain for themselves the same degree of profit that the skilful middlemen in the cities manage to secure: or they can reduce production. Combination among farmers for selling has hitherto proved very difficult, though it is now being tried in Canada: reduced production is the more certain method, but the authors recognise that it is undesirable. As we read the book, we feel that the remedy, even if successful in curing the farmers' ills, would leave the world worse off than before. The authors show that part of the farmers' difficulties arise from the poverty of many people in Europe: instead of eating wheat and meat they live on potatoes and vegetables, and if the prices of farm commodities rose still further, these unfortunate people would be still worse off.

The authors attach more importance to economic adjustment of prices than to scientific advances in methods of production. Indeed they show that plant diseases, insects, and unfavourable weather may even help some farmers by temporarily forcing up prices. Time is the great healer and the only consolation in the present position is the authors' clearly expressed view that "when a period of agricultural depression ends, a period of agricultural prosperity follows." We should have liked the authors' opinions on the method that British scientific workers are advising farmers to adopt: an increase of farm produce per unit area so as to obtain the extra sacks of corn needed to meet the extra charges. Great Britain differs from the United States in importing a great amount of food annually. An increased home production in Britain would lessen the need for imports. In the States, however, a great amount of food is already exported and for any extra production an outlet must be found.

The agricultural student will find the book unusually interesting and stimulating, and its value is enhanced by the number of curves and diagrams presenting the statistical data in a form easily grasped by the reader.

E. J. R.

Popular History of Astronomy.

Histoire de l'astronomie. Par F. Boquet. (Bibliothèque scientifique.) Pp. 510. (Paris: Payot et Cie, 1925.) 25 francs.

THERE seems to be a demand in France for popular books on the history of astronomy, as we reviewed a book with the same title, by E. Doublet, a little more than two years ago (vol. 110, p. 600), and a similar work by E. Lebon was published in 1899. M. Boquet does not pretend to have studied the original works of astronomers of past ages, nor the

extensive literature of monographs on special subjects. He merely claims to give a résumé of a number of books, of which he gives a list. His authorities range from original and valuable works like those of Delambre, Grant, and others, down to popular and uncritical books which he would have been better without. For to M. Boquet all authors of printed matter seem to be equally authoritative, and whenever they differ he leaves the decision as to who is right to the reader. An amusing example of this helplessness is found on p. 254. When speaking of Copernicus, the author says that "during the campaign of 1805, some authors say 1806, Napoleon visited the house in which Copernicus was born." Surely it would have been easy to find out whether Napoleon was in Prussia in 1805 or not. As a matter of fact his visit to Thorn was in 1812. There are a great many cases like this throughout the book. The readiness of the author to accept any statement as true, no matter by whom it is made, so long as nobody has been of a different opinion, lets him accept as authentic the picture of "the well of Eratosthenes" published in 1914 in the *Observatory* magazine, as he has overlooked a refutation given in the same volume; and so in many other cases.

The greatest fault of this book is that it devotes far too much space to astronomers who were not of the first rank or even of the second, and far too little to the great leaders. Information of the kind given might have made the book useful as one of reference, if it had been provided with a good index. But there is no index, and even the table of contents is very meagre, filling only one page. Any one hoping to find an account of how our knowledge of the motions and nature of the heavenly bodies has been gradually developed, will be disappointed. The author allows almost exactly the same amount of space, seven pages, to each of the greatest astronomers, except to Hipparchus and Ptolemy, to whom he gives a page or two less, because we do not know anything about their lives. Under Hipparchus, as everywhere else, we find old statements repeated, though they have been refuted. It was not a new star but a comet which appeared in 134 B.C., and the catalogue of Hipparchus did not contain 1080 stars, but only about 850, a matter of some importance, as it helps us to realise that Ptolemy did not simply borrow all his star-places from Hipparchus. M. Boquet is aware that Laplace recognised Ptolemy's catalogue as an independent work, but as usual he does not enter into details, and simply says "Il est difficile de conclure." How the epicyclic system began and how it was gradually improved until it became the complicated Ptolemaic system, is not described. Similarly, under Copernicus nothing is said as to how he came to discover the motion of the earth,

except that we might as well ask why a genius is a genius. "Ici la réponse est difficile." The same is the case when we come to Newton; but here at any rate we find some new information. It appears that Newton competed for a fellowship and obtained eleventh place among eleven candidates. One must agree with M. Boquet, when he says that it was not very brilliant. But where did he get that story from? It is also news to us to hear that it is not known when Newton wrote the "Principia." After that, the reader is prepared to meet with the old fables, how Newton did not know of Picard's results as to the size of the earth until 1682, and how he went mad ten years later, and so on.

J. L. E. D.

Our Bookshelf.

Alpine Flora for Tourists and Amateur Botanists: with Text descriptive of the most Widely Distributed and Attractive Alpine Plants. By Dr. Julius Hoffmann. Translated by E. S. Barton (Mrs. A. Gepp). New edition. Pp. xiv + 121 + 43 plates. (London: Longmans, Green and Co., 1925.) 12s. 6d. net.

A NEW edition of Mrs. Gepp's English translation of this well-known flora will be welcomed by many to whom, though not themselves botanists, the flora of the Alps makes an irresistible appeal. The book itself is a tourists' flora rather than a scientific work. It aims at affording a ready means of recognising the more conspicuous or characteristic species of the Central European Alps—not merely the Swiss Alps. It lacks the "keys" to genera and species found in more scientific floras, such as Schinz and Keller's "Flora der Schweiz," and, for purposes of identification, frankly relies, in the first instance, on its 43 coloured plates, on which the great majority of the species described are figured. Within the limits determined by the plan of the book, the brief descriptions in the text are good. Detailed floral structure is omitted, the diagnostic characters employed being for the most part those of habit, size, leaf, and perianth. Simple technical terms are freely used, but as there is an adequate glossary, amateurs should experience little difficulty. A slip occurs in the description of the species of *Anemone*, the perianth being referred to in one case as "sepals," and in another as "petals."

Useful notes on distribution, habitats, and altitudes are given. On the whole, the figures give sufficiently accurate representations of the plants for purposes of not too critical identification. The colouring, if a little crude, is distinctly better than that found in many similar works. As is to be expected, the success of the colouring varies a good deal. The colours of *Gentiana acaulis*, for example, have been very fairly reproduced, but one misses the wonderfully haunting blue of *G. bavarica*. In comparatively few examples (e.g. on plates 5 and 26) have fruits been figured: some others, such as the very characteristic plumed fruits of *Dryas octopetala*, *Geum montanum*, and *G. reptans*, might well have been included. In the case of very small flowers, too, the addition to a habit figure

of a single enlarged flower (as has been made in a very few cases) would be a decided advantage.

In the present edition one of the original plates has been omitted, but four new ones (including selected rushes, sedges, grasses, ferns, lycopods, mosses, and lichens) form a useful addition. The book is well printed, but is perhaps unnecessarily heavy; considering that it is intended as a travelling companion for tourists, a lighter paper might have been used. The publishers would also do well to look more carefully to the binding: the pages in the review copy show an alarming tendency to break loose from their moorings.

The Chemistry of Enzyme Actions. By K. George Falk. (American Chemical Society Monograph Series.) Second and revised edition. Pp. 249. (New York: The Chemical Catalog Co., Inc., 1924.) 3.50 dollars net.

THIS book retains the main features of the first edition, although it has been approximately doubled in size. Enzyme actions are considered so far as possible as ordinary chemical changes, and the author's views on the theory and mechanism of chemical reactions are applied to them. A preliminary study of his book on this subject would probably be of advantage to the reader, as the sketch of the subject in the introduction to the present work suffers from enforced condensation. Briefly stated, the author is a strong supporter of the addition theory of chemical change. The mode of treatment renders the book rather difficult reading, but there is a constant appeal to the critical faculty which stimulates the reader's interest.

A good account of the recent work bearing on the vexed question of the chemical nature of enzymes is given, including the author's suggestive experiments on the selective action of ester-hydrolysing substances, made to glean indications regarding the chemical nature of the lipases. The whole problem is still in its infancy, and a consideration of the general physical and chemical properties of the enzymes leads only to the tentative generalisation "that an enzyme action is due to a chemical grouping of marked instability present in a complex molecule of colloidal nature." The colloidal character of all known enzymes is thus recognised but is kept carefully in the background in the author's consideration of the nature of enzyme action, since he believes that "fundamentally the chemical reactions of a substance are based upon its chemical properties," although its physical state will naturally modify the relations observed. He even holds out the hope (p. 233) of being able to obtain the "enzyme property" in a crystalloidal or readily dialysable form, thus abandoning the tentative suggestion just recorded.

A somewhat sketchy chapter on the uses and applications of enzymes and a long and detailed account of experiments on enzyme actions of tissues and tumours—the treatment of which is quite out of proportion to that of the rest of the work—are also included in the book, which concludes with a summary of the present status of the enzyme question.

As will be seen, the work is one only for the advanced student or investigator, who is able by the exercise of his critical faculty to enjoy the somewhat novel presentation of familiar facts. A. H.

Bismuth Ores. By Robert Allen. Pp. ix+62. 3s. 6d. net. *Antimony Ores.* By Edward Halse. Pp. ix+102. 5s. net. *Bauxite and Aluminium.* By W. G. Rumbold. Pp. ix+110. 6s. net. (Imperial Institute: Monographs on Mineral Resources with special reference to the British Empire.) (London: John Murray, 1925.)

THE above three volumes issued by the Imperial Institute form a further contribution to the series of monographs on mineral resources which the Institute has issued from time to time, and these follow closely the lines upon which their predecessors have been laid down. Each book consists of three sections, the first dealing with the characters and composition of the ores of the metal treated of, the uses and properties of the metal and of its more important alloys, and the metallurgy of the metal, that is, the processes by which it is extracted from its ores. The second section gives an account of the distribution and occurrence of the ores of the metal within the British Empire, these occurrences being described in some little detail; the third section describes the sources from which the ores of the metal in question are obtained from foreign countries, that is to say, countries outside of the British Empire. Statistics of production are usually given, though these are to-day of comparatively little importance in view of the fact that full official statistics are published regularly by the Imperial Mineral Resources Bureau. Each volume, however, concludes with a very useful bibliography of the metal to which the volume refers.

With regard to the individual volumes themselves, there is little to be said. It so happens that the production of each one of the three metals here discussed is in relatively few hands, and that there is accordingly a certain amount of secrecy concerning the processes of extraction employed, their general principles being of course known, though many of the minute details are looked upon as trade secrets; it need scarcely be said that it quite often happens that these minor details may make all the difference in the economic success or failure of a process. In every case the work appears to have been done carefully and painstakingly, and appears to be upon the whole quite accurate. No doubt the information given would not be sufficient for the specialist, but the object of these books is not to provide information of that type, but rather to give a general survey of the subject which will suffice for the objects of the average inquirer, and this purpose is quite well fulfilled by the books before us. It must often happen that the business man requires some general knowledge of the origin and mode of distribution of the materials in which he deals, and the object of these monographs is to supply information of that kind.

Anthropology. By Prof. A. L. Kroeber. Pp. x+523. (London, Calcutta and Sydney: George G. Harrap and Co., Ltd., n.d.) 12s. 6d. net.

THE professor of anthropology in the University of California has written a notable book—one which deserves to be known and studied in Europe as well as in America. He seeks to provide answers to the questions: When and where did the races of mankind

become differentiated? When and where did they come by their languages? When and where did they acquire their customs, beliefs and ways of living and their manner of doing things? He does not answer these questions by culling quotations from authorities, but, using his well-stocked mind, a wide personal experience, a sane judgment, and a happy gift of expression, returns answers that all who read may understand and, at the same time, feel that they are in touch with the live problems of anthropology. His main aim is to explain how peoples in every land have come by their cultures, particularly how the peoples of the New World, both ancient and modern, came by theirs.

Amongst European anthropologists, that school which regards inventions, beliefs and practices, now widely spread amongst living peoples, as having arisen in single centres, is gaining adherents every day. Prof. Kroeber, while open to the fact that cultures do often spread by borrowings and by migrations, champions the cause of independent and multiple origins. The practice of the *cowade* prevailed in Europe and Brazil. That fact is construed by the growing school as evidence that there had been a culture drift from the Old World to the New. Prof. Kroeber, from the same facts, draws the inference that the natives of Europe and the natives of Brazil were provided with a common impulse, and that under the influence of this impulse they devised a common practice. Although the reviewer's sympathies are altogether against "independent origins," it is well that "migrationists" should be thoroughly acquainted with the other side of their case. They will find that Prof. Kroeber has culled much from the ancient civilisations of Mexico, Maya and Peru which deserves their serious consideration. Beyond all this, the book is one of the most comprehensive and attractive of text-books on anthropology.

Chronique des événements météorologiques en Belgique jusqu'en 1834. Par E. Vanderlinden. Pp. 329. (Bruxelles: M. Hayez, 1924.) 16 francs.

REGULAR meteorological observations are of comparatively recent origin, but mankind has always been interested in the weather, and numerous meteorological references are scattered through the literature of all countries from the earliest times. The importance of collecting these records has been recognised by the International Meteorological Committee, and in recent years several eminent meteorologists have occupied themselves with the task, especially the late A. Angot in France and G. Hellmann in Germany. Last year Sir Richard Gregory presented us with a summary of the early meteorological records of the British Isles, and we have now to welcome an exhaustive compilation of the material from Belgium by the veteran meteorologist, E. Vanderlinden, commencing with the record of a rainy summer in the year A.D. 120, and continuing until the beginning of regular meteorological observations at Brussels in 1834.

The records deal with mild or severe winters, dry or rainy summers, early or late frosts, floods and storms; the most valuable are those which were recorded owing to their agricultural importance. It is interesting to notice that the author recognises three stages in the

recording of meteorological notes; in the most ancient medieval chronicles the remarks are generally brief and to the point—"severe winter." Later they become longer and more fanciful, often verse is employed. In the third stage the facts are distorted to fit the narrator's theories or his love of the marvellous, and it is not until the end of the eighteenth century that a scientific character is recovered. The usual historical difficulties were met with, especially in the dating of events which occurred in winter, but the author appears to have performed the critical part of his work with good judgment. The documentation is excellent; for each year, after a brief summary of the phenomena in French the original remark is quoted, followed by a reference to the chapter and page of the authority. At the end of the work the principal phenomena are tabulated.

Einführung in die allgemeine Kohlenpetrographie. Von Dr. Robert Potonié. Pp. x+285. (Berlin: Gebrüder Borntraeger, 1924.) 13s. 2d.

THIS work is not only of importance in itself, but also derives considerable interest from the fact that it embodies the continuation, by a distinguished son, of work commenced by a distinguished father, for Henry Potonié's work on the structure of coal may be regarded in many respects as a classic. The author describes the object of the work by quoting a definition of Weinschenk to the effect that petrography considers the origin, the characteristics, and the mode of decomposition of rocks, and notes that, from this point of view, but little attention has been paid to the study of coal, so that the petrography of coal is still in its infancy. He further quotes a sentence from Dannenberg to the effect that, for practical purposes, distinctions drawn from a mineralogical or petrological point of view are of but little importance, but he shows that this statement is only true because so little has been done towards the scientific study of the subject of the present book.

Dr. Potonié discusses first the modes of formation of coal, the macroscopic structure of coal and its origin, the microscopic structure of coal and its causes, and then, in some detail, the petrographic constituents of coal, and the various materials from which these have been built up. It need scarcely be said that a very large number of the views which he sets forth will not be universally accepted, our knowledge of the subject being in fact too imperfect to admit as yet of anything like finality, but the book before us undoubtedly constitutes a very important contribution to the study of a subject which is not only of profound scientific interest, but also may well prove to have very important practical bearings.

The Student's Handbook of British Mosses. By H. N. Dixon. Third edition, revised and enlarged. Pp. xlviii+582+63 plates. (Eastbourne: V. V. Sumfield; London: Wheldon and Wesley, Ltd., 1924.) 24s.

THIS well-known work has now been re-issued in a third edition which will prove very welcome to bryologists. Thinner paper, improved type, and new drawings for many of the plates serve to make the volume both of more convenient size and also more attractive. Much new material has been incorporated

embodying the essence of recent work on this subject. The glossary and instructions are fuller, and more conveniently placed in reference to the illustrations, while the plates contain a large number of additional details. This is especially noticeable in the illustrations of *Bryum*, where capsules are now figured for most of the species. *Bryum purpureum* on Plate XLII. should, however, presumably be *B. purpurascens*, and there are also slips in the lettering of Plates XII. and XVII. In the former case (*Campylopus*) the figures lettered A to E should be C, D, E, A, and B, while in the latter case (*Fissidens*) the plates D, E, and F are incorrectly described at the foot of the page, although correct in the text. Slight modifications have been made in the treatment of the *Sphagna*, *Dicranum*, and *Thuidium*. Stirton's names are indicated in the synonymy where necessary, but the previous treatment of these names has not always been maintained. *Zygodon teichophilus* Stirt. is now given as *Z. lapponicus* instead of *Z. Stirtoni* (as in the *Journal of Botany*, 1923, p. 69), while *Mollia thrausta* Stirt., p. 245, is not now taken as equivalent to *Trichostomium tortuosum* var. *fragipolium*. The quality of the book is quite maintained at its former high and critical standard, and it will continue to be invaluable to workers in this field.

Industrial Electricity. By Prof. Chester L. Dawes. (Electrical Engineering Texts.) Part I. Pp. xiv + 371. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 11s. 3d. net

MANY technical high schools in America have elementary electrical engineering courses. This book has been written for the use of students attending these courses and the author has done his work well. The explanations are clear, and the machines described are all in everyday use. The first five chapters give a good grounding in the elementary principles of magnetic and electric circuits, a large number of illustrative problems being given to show concrete applications of these problems. The rest of the book gives a bird's-eye view of electrical engineering. Owing to the great industrial importance of batteries, as, for example, in radio work and for motor-cars, we are glad that due space has been allotted to describing their underlying principles and how to maintain their efficiency and life. A typical ignition system and a typical lighting and starting system for motor-cars are also fully described. The next volume will discuss direct and alternating current power distribution. The author perhaps states a fundamental law of electrostatics too dogmatically: "For every positive charge in the universe there must exist an equal negative charge." It is a bold thing to draw conclusions about the universe from our terrestrial experiments.

Die Schollen der norddeutschen Moränen in ihrer Bedeutung für die diluvialen Krustenbewegungen. Von Dr. Georg Petersen. (Fortschritte der Geologie und Paläontologie, Heft 9.) Pp. iv + 179-274 + 1 Tafel. (Berlin: Gebrüder Borntraeger, 1924.) 6s. 9d.

Low level glacial deposits often include large transported masses which are known in Germany as a variety of "Schollen." They there consist of sedimentary blocks ranging in age from the Jurassic to Glacial.

The majority belong to strata from the Chalk to the Miocene. These glacial Schollen have been catalogued and described in an admirable monograph by Dr. Georg Petersen of Trier. He deals with 459 examples, including a few from Russia and Denmark: 205 of them have been discovered by bores; the remainder are exposed in cliffs and quarries or on the surface. The largest is a sheet of chalk at Sternitten in Samland, which is 4 km. long by 2 km. wide and 14 to 20 m. thick. The great majority of those measured are less than 10 m. long. The Sternitten Scholl has been carried 4 km. from the bed of the Baltic. As a rule they have been transported a short distance, but one near Leipzig has apparently been brought from Rugen. The author attributes the transport to glacial action, and directs attention to the view of Prof. Keilhack, who has pointed out their resemblance to the results of drifting ice-floes in the Baltic during severe winters. A special feature of the monograph is the author's view that the Schollen afford evidence of widespread Pleistocene earth-movements in North Germany.

Der mittlere Jura im Hinterlande von Dar-essalaam (Deutsch-Ostafrika): Beiträge zur Geologie und Stratigraphie Deutsch-Ostafrikas III. Von Edwin Hennig. (Monographien zur Geologie und Paläontologie. Serie 2, Heft 2.) Pp. iv + 131 + 4 Tafeln. (Leipzig: Gebrüder Borntraeger, 1924.) 33s.

THE Jurassic geology of East Africa affords the main evidence as to the early history of the western part of the Indian Ocean. Hence every addition to the scanty fauna of the East African Jurassic is of importance. Prof. Edwin Hennig, well known from his "Geology of Württemberg" and his contributions to the great monograph on the Tendaguru beds of East Africa, in this monograph describes a miscellaneous collection of fossils from several localities between 70 and 90 miles west of Dar-es-Salaam along the railway to Lake Tanganyika. The fossils are mainly lamellibranchs, of which three new species are described. The horizons are assigned by Prof. Kennig to a continuous series from the Aalenian to the Oxfordian. He recognises that the material is inadequate for these determinations to be free from doubt; but they are consistent with the sequence of localities. In considering the affinities of the fauna he refers to those of Madagascar and India, but does not mention the later literature on the contemporary fossils of Kenya Colony. The price of the book is 33 shillings, which for a paper-bound booklet of 131 pages with 4 cheaply produced plates is very high.

Elementary Physics: for Medical, First Year University Science Students and general Use in Schools. By G. Stead. Pp. xiv + 453 (London: J. and A. Churchill, 1924.) 10s. 6d. net.

It is quite safe to predict that this book will be much used by medical students, for whom it is primarily intended, for it would be difficult to find one better suited to their peculiar requirements. The mathematics has been reduced to a minimum, and the presentation is probably as attractive as it can be made to students who are not as a rule prepared to take their physics very seriously; that is to say, who are somewhat averse from hard thinking and clear

reasoning. It is very well printed and illustrated, and is remarkably good value.

As a text-book for the general science student it is perhaps a trifle less satisfactory. The logical development is not always above criticism, as, for example, in the introductory paragraph of the section on heat, where the idea of quantity of heat is invoked in order to explain that of difference of temperature. Again, the theoretical justification of Archimedes' principle is not clearly set forth, and it is to be feared that the explanation of Newton's Third Law will leave the student just where he was in his acquaintance with those mysterious twins—action and reaction. Apart from these and one or two other exceptionable items, there is little to criticise and much to commend.

Radio, Beam and Broadcast: its Story and Patents.

By A. H. Morse. Pp. 192. (London: Ernest Benn, Ltd., 1925.) 12s 6d. net.

THE author gives a good account of the art of radio-communication. In an appendix he quotes British and American patent specifications or gives extracts from them describing the main steps in the evolution of the art. Many wonderfully accurate guesses into the future have been made, but few are so wonderful as Du Maurier's drawing published in *Punch* of 1878 of what appears to be an elaborate home radio set and a lady telling her page-boy to turn on the tap for the concert from Covent Garden, etc., at stated times in the evening. Long-distance broadcasting was anticipated, as one of the panels is marked "Bayreuth." In 1892 Sir William Crookes, in a paper in the *Fortnightly Review*, makes an excellent forecast of radio-telegraphy, suggesting that 50 yards would be a suitable wave-length, and that the instruments for reception would have to be tuned to this wave-length. We are inclined to agree with the author that, in the near future, broadcasting of local urban interest only will be effected over existing telephone or lighting wires and so kept out of the ether. The ether is already becoming congested, mainly due to broadcasting. A single broadcasting station takes as much of the ether as would accommodate at least ten radio-telegraph stations.

Why the Weather? By Dr. Charles Franklin Brooks, with the Collaboration of John Nelson and others. Pp. xvi + 310 + 21 plates. (New York: Harcourt, Brace and Co., 1924.) n.p.

THE aim of this book is to present the elements of the physics of the atmosphere in a simple manner. It covers rather a wide field, and does not delve very deeply into any portion of the subject. The style is chatty, rather than simple, and gives the impression that the author has made a too strenuous effort to write down to the level of his public. While the author states a number of facts which would be unknown to the general reader, his theory is not always reliable. For example, he ascribes the "table-cloth" on Table Mountain to the cooling effect upon the air of the low temperature of the mountain top, instead of to adiabatic cooling of the air blown up the slopes of the mountain. It is stated that the earth has grown from a comparatively small cold body by the addition of mass by showers of meteors falling upon it, a theory

which is by no means so widely accepted as might be inferred from the author's bold statement of it. On the whole, the book can be recommended to the general reader as an introduction to the physics of atmosphere. The illustrations, mainly of cloud forms, are very well selected.

Studies in the History of Political Philosophy before and after Rousseau. By Dr. C. E. Vaughan. Edited by A. G. Little. Vol. 1: *From Hobbes to Hume*. Pp. xxix + 364. Vol. 2: *From Burke to Mazzini*. With a list of the Writings of Prof. Vaughan, by H. B. Charlton. Pp. xx + 6 + 339. (Manchester: At the University Press; London: Longmans, Green and Co., 1925.) 2 vols., 42s. net.

THESE volumes will be valued by all those who knew or who passed under the influence of the distinguished professor who held the chair of English first at Cardiff, then at Newcastle, and later at Leeds before he died in 1922. The books and articles published by him in his lifetime were all of the nature of students' manuals or were aids to study. Apart from his work in the classroom, he was engaged throughout the active period of his life in writing a "History of Political Philosophy," and the studies for this, some of which were left in a finished, others in an unfinished, condition, but none of them marked for press, have now been edited and published. The whole is a monumental work of the first importance.

The Races of Man and their Distribution. By Dr. A. C. Haddon. New edition. Pp. viii + 184 + 10 plates. (Cambridge: At the University Press, 1924.) 6s net.

THIS is a new edition, entirely rewritten, of a small and very useful volume by the pioneer field-worker and veteran anthropologist of Great Britain. In its present form the book is the best succinct statement of the principles of racial classification, of the physical characters of each stock, and of the distribution of the varieties of man. In the analysis of the concept of "race" and the discussion of the main criteria of physical anthropology, which form the first part of the volume, the modern theories and points of view of cultural anthropology have been taken into account. In the description of the main races which follows, the book does not go beyond the limit of physical anthropology. Within these, it is the best and most authoritative statement of the subject. Mainly designed as a text-book for the beginner and the general reader, it will be also valuable as a handy work of reference for the specialist.

The Match Industry: its Origin and Development. By W. H. Dixon. (Pitman's Common Commodities and Industries Series.) Pp. x + 150. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 3s. net.

THE author gives an interesting account of the manufacture of matches. The style suffers owing to the breaking up of the text into a large number of very short paragraphs, generally single sentences. The historical part is incomplete and disconnected, and in future editions more attention might be given to this side, and in particular the claims of Walker should be more critically examined.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Ionisation produced in Air during the complete Absorption of Slow Electrons.

A DIRECT determination of the average number of pairs of ions produced by a slow electron of given initial velocity during its complete absorption in a gas has been made possible by the use of high-speed pumps. Electrons are accelerated from a tungsten filament and passed through a capillary tube into an ionisation chamber containing gas at a suitable pressure, the gas issuing from the capillary being removed fast enough to maintain a good vacuum near the filament. The number of electrons entering the ionisation chamber is measured by a movable Faraday cylinder placed inside the chamber very close to the end of the capillary; then after the cylinder has been removed from the path of the beam, the ionisation produced in the gas is determined in the usual way.

If all the electrons had the same energy at the moment they leave the capillary tube, the ratio of the number of ions to the number of electrons would give the average ionisation produced by each electron, the initial energy being determined by the accelerating potential. In practice, it was found impossible to obtain a homogeneous beam, and the present experiments were carried out with beams in which from 40 to 80 per cent. had velocities corresponding to the full accelerating potential, while the remainder were slow compared with these. The homogeneity was determined for each experiment, *in vacuo*, by applying retarding potentials to the Faraday cylinder.

The values found experimentally for the number of ions per electron are therefore too low. A first approximation to the true value may be obtained by increasing the experimental values by a factor $100/P$, where P represents the percentage of full-velocity electrons in the beam. When this is done, it is found that the ionisation per electron in air increases steadily with the initial energy of the ionising electron, over the range from 100 to 1000 volts. Although the experimental error was certainly not more than 10 per cent, uncertainties in the composition of the beam gave rise to a possible error in the corrected values of the order of 20 per cent. The following table gives mean values:

Initial Energy of Electron in Volts.	Pairs of Ions produced in Air.	Energy expended per Ion-Pair in Volts.
200	5.8	35
400	14.5	28
600	24	25
800	35	23
1000	45	22

It will be observed that the average energy expended per ion-pair decreases towards the ionisation potential (17 volts) as the initial energy of the ionising electron increases, and over this range is less than any value previously published. It is, however, comparable with that found by Geiger (33 volts) from measurements on α -particles, where most of the ionisation is due to δ -rays. The behaviour of helium is similar, the energy expended per ion-pair in this

case attaining a value much closer to the first ionisation potential (25 volts) than in air, from which it follows that, in this gas, very little energy can be lost in non-effective collisions.

J. F. LEHMANN
T. H. OSGOOD.

Cavendish Laboratory,
Cambridge, August 3.

Lightning-conductors.

"Who would have thought that man would succeed in drawing off the lightning and conducting it to an outlet?" The quotation is taken from one of a series of small octavo volumes, written certainly by one intimately acquainted with his subject, and published anonymously in Amsterdam in 1782-3 under the title "Tableau de Paris." The date, which is within about ten years of the "Terror," seemed to promise matter of interest to the student of the French Revolution; and the expectation proved to be amply justified. While the work necessarily contains much that is a sinister omen of approaching catastrophe, it also covers a wide and diversified field of contemporary life and thought, and, in particular, it contains many evidences that a very fine spirit of experimental and speculative research was awake in the France of that period. Each *tableau* has a short chapter to itself, the above quotation being taken from one headed "Para-tonnerre." The author's satisfaction with the new discovery would perhaps have been considerably tempered had he known that nearly a hundred and fifty years later the solution of the problem of defence against lightning would be recognised as still far from complete, that the control of the thunder-bolt would furnish cause for anxious study to the scientists of the twentieth century.

In view of the recent severe thunderstorms, the detailed description given of the earliest lightning-conductors erected in Paris may be of interest.

"These great pieces of apparatus, which modern physics has designed to protect buildings from lightning, are numerous in many towns in the heart of the provinces, but they are rare in the Capital. The Abbé Bertholon, professor of experimental physics of the States-General of Languedoc, showed the greatest zeal in opposing the weapons of science to the attacks of lightning. It was he who superintended the construction of the first lightning-conductors in Paris—an honour due to one who had already erected the superb *para-tonnerres* at Lyons. There are now two to be seen, one placed on the Hôtel de Charost, faubourg Saint-Honoré. It is 185 feet long; while the part in the earth, terminating in water, has a depth of 28 feet. The second is at the other end of Paris, on the convent of the *religieuses augustines Anglaises*. It is 188 feet long; and the portion buried in the earth, which dips under water at the end, has a depth of 90 feet—a depth with which no other lightning-conductor of this kind can be compared."

"The pieces composing this apparatus are joined together with long screws [*à vis profondes*], and the precision of the work is such that all the bars seem to be one piece. Metallic connections, skilfully arranged, are put wherever necessary or useful [*Des communications métalliques, soigneusement ménagées, se trouvent dans les endroits où elles sont nécessaires ou utiles*]. Thus the lightning has to obey the Abbé Bertholon, and follow the direction which he has prescribed."

Unfortunately, the kind of metal used is not mentioned. One is inclined to think, however, that if copper rods were employed this would not have escaped the writer's notice. This rather doubtful consideration would seem to indicate that the material was probably iron. It is significant, also, that no claim is made on the Abbé Bertholon's behalf, with

respect to the *invention* of the "lightning-conductor." Franklin, whose first "lightning-rod" (1752) anticipated the French *para-tonnerres* by a good many years, was in France somewhere about this time, and their introduction into the latter country was probably due to his initiative.

One other extract may be given for what it is worth. Perhaps the two kinds of lightning observed may have some analogy to the A and B discharges noted by Sir Oliver Lodge:—

"It has been completely demonstrated, by a great number of observations, that the lightning often rises from the earth. If the electricity, the true cause of lightning, is in excess in the clouds, the discharge is earthwards. If, on the contrary, it is accumulated in the bosom of the earth, it escapes to expand itself into equilibrium in the atmosphere. In order that a building may be defended against these two dangers, it is therefore necessary to establish *ascending lightning-conductors* [*des para-tonnerres ascendants*] against the lightning which rises, as they have been established against that which falls. It is necessary to have recourse to the ascending lightning-conductors of the Abbé Bertholon. He has safeguarded in this way a belfry at Lyons, on which the thunder (*sic*) had very often fallen." (The appropriateness of the example cited is very far from clear.)

The extracts are from vol 6, pp 238-242, of the work mentioned H. C. BROWNE

Dublin, July 27.

Fish Poisons as Insecticides.

In many widely separated tropical countries it has been the rather curious custom of the natives to catch fish in lakes, rivers, and creeks by means of certain poisonous plants; the leaves, stems, or roots being used for this purpose. The water extract obtained by macerating the appropriate part of the plant is poured into the stream, and the fish being rapidly stupefied by it are readily caught. The practice is now generally discouraged, owing to the heavy mortality ensuing amongst the small and immature fish.

Extracts obtained from some of these plants have been shown to have an insecticidal action of a high order. Among these are different species of *Derris* and *Tephrosia*, both of which contain non-nitrogenous constituents highly poisonous to fish. Recently, Mr R. A. Altson, of the Botanic Gardens, Georgetown, British Guiana, has secured for us two plants employed by the aborigines of that country as fish poisons and known to them as "Black and White Haiari."

Mr Altson refers these plants to the order Leguminosæ and states that the Indians use them in the following manner. "The roots of White Haiari and the stems of Black Haiari are beaten out into a 'horsetail' and shaken into water, which afterwards is thrown into the creek. In about ten minutes the fish in that area are either stupefied or killed and float to the surface."

Extracts prepared from Black and White Haiari with water and organic solvents have been recently tested in this laboratory as contact insecticides, and both, but particularly those prepared by the use of organic solvents, have been found to be highly poisonous to aphides.

It is of interest that all of the above plants belong to the order Leguminosæ, while those of other natural orders which are used as fish poisons have not so far proved in our investigations at Rothamsted to be of much interest from an insecticidal point of view.

Various investigators have isolated the poisons from *Derris elliptica* and *Tephrosia vogelii*, but little is known of their constitution although suggestions

have been made as to a possible lactone structure. No information is available, so far as we are aware, about the toxic constituents of Black and White Haiari. We have, however, obtained colourless crystalline derivatives from both, which may be of significance in this respect.

Black and White Haiari may prove of economic importance as insecticides. F. TATTERSFIELD.

Rothamsted Experimental Station,
Harpenden, July 15

X-Ray Diffraction Patterns from Plant Fibres.

DIFFRACTION patterns obtained from plant fibres, ramie, hemp, etc., by using a method similar to that of Hull for crystal powders (*Phys. Review*, 10, 2, 661, 1917), do not agree in certain particulars with the data reported by Herzog and Jancke in *Zeits für Physik*, 3-3, 196 to 198, 1920. They give a list of eight sets of planes, based on data obtained by using the "white light" radiation from a copper anticathode, and eliminating by inspection the $K\beta$ reflections. In our work, molybdenum radiation was used and a monochromatic beam was obtained by filtering through a zirconium oxide screen.

As will be seen in the table, several interplanar spacings check satisfactorily, others, however, do not. We found that by manipulating the exposure and size of slit, a line which might be accepted as 5.80 under one set of adjustments could be resolved into two lines, 6.10 and 5.40. Similarly, 3.30 and 2.60 lines were resolved as shown in the table. Merely for convenience the lines are designated by the figures which express the value of the interplanar spacings. Certain orientations of the bundle of fibres were also necessary in order to produce the separation of the lines.

INTERPLANAR SPACINGS IN PLANT FIBRES

Reported by Herzog and Jancke. $K\alpha Cu = 1.54$.	New Values.	Remarks
5.80	6.10 5.40	Resolved
4.02	3.98	
3.30	3.40 3.20	Resolved
2.90		$K\beta$ line
2.60	2.62 2.58	Resolved
2.18 2.01 1.10	2.17 2.03 1.11	

The so-called 2.90 line was readily found when the unfiltered beam was used, but when the $K\beta$ wavelengths were screened out, it failed to appear. The $K\beta$ reflection from the 2.60 planes seemed to have contributed largely if not entirely to that line. Among the thirty odd lines which we found with the monochromatic beam there appears a very faint 2.93, but that line is so weak that it does not seem probable that it is the one which Herzog records.

Only the few lines needed to make the above corrections are reported here; a more detailed discussion of the patterns and the lattice will appear elsewhere. O. L. SPONSLER.

University of California, Southern Branch,
Los Angeles, California

A Low Frequency Oscillator.

It may be of interest to readers of NATURE who are working with low frequency to know of a new form of oscillator

At present I am using a low frequency oscillator which gives excellent results with a delicate adjustment of the frequency to a given value. The circuit used is that in which the oscillations are produced by coupling the grid and plate circuits of a thermionic

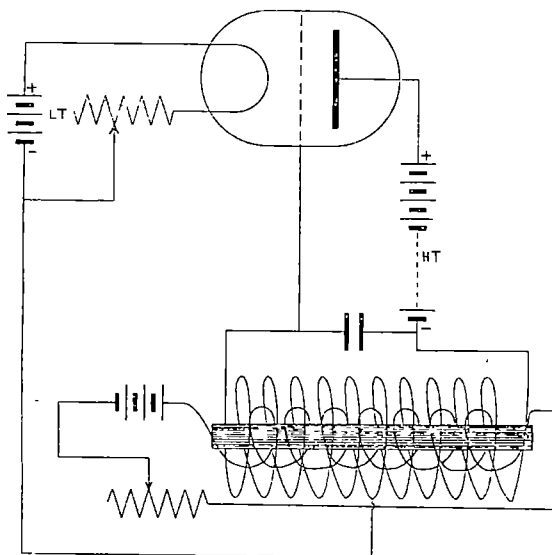


FIG. 1.

valve by mutual inductance and capacity. In the ordinary circuit the frequency is changed by sliding an iron core. In the circuit now described the inductance is altered by passing a D.C. current round an iron core. The pitch of the note for a given capacity changes as the exciting current changes. There are many advantages of this oscillator, one of which is the maintenance of symmetry for the different inductances. A full description with test details is now in course of preparation for publication. The diagram (Fig. 1) gives an idea of the oscillator circuit and how it works.

C. CONSTANÇON.

University of the Witwatersrand,
Milner Park, Johannesburg,
July 1.

Doublet Separation in C II and Si IV.

FURTHER work has been done on the ultraviolet spectrum of carbon and silicon using a diffraction grating having a radius of 192.1 cm. The resultant dispersion of about 9 Å.U. per mm. has enabled us to obtain the following spectral lines in Fowler's¹ series for C⁺ as doublets and to measure the separation as shown in the following table:

Line Bohr's Notation	$\Delta\nu$ observed.		$\Delta\nu$ as calculated by Fowler. ¹
	2nd order.	3rd order.	
$\left. \begin{matrix} 2\pi_1-3\sigma \\ 2\pi_2-3\sigma \end{matrix} \right\} \lambda=858 \text{ Å.U.}$	64	60	58
$\left. \begin{matrix} 2\pi_1-3\delta \\ 2\pi_2-3\delta \end{matrix} \right\} \lambda=687 \text{ Å.U.}$	64.5	..	58

The separation of the components of the line at 858 Å.U. was measured in the second order on nine

¹ Proc. Roy. Soc., March 1924.

plates and in the third order on three plates, using a comparator reading to 0.001 mm. and taking the average obtained from ten settings on each component. The measurements on 687 Å.U. were made in the second order only and on two plates.

The third member of the first sharp series was not recorded by Fowler, but was found by one of us² as an unresolved line at 577.4 Å.U.

We have also measured the separation of the doublets at 1335 and 1036 Å.U., and the results from seven different plates, using the second order, give $\Delta\nu=65$ for the 1335 doublet and $\Delta\nu=62$ for 1036. The focussing in the case of the latter was not so sharp as for 1335, but the results seem to indicate that the two separations are the same and that 1335 therefore belongs to C⁺ as Millikan³ has already stated.

In the series of Si IV as recorded by Fowler,⁴ we have resolved the doublet $3\sigma_1-4\pi$, $3\sigma_2-4\pi$ in the second order and find the separation $\Delta\nu=153$.

The following lines in these series not previously recorded have also been found: $4\sigma-6\pi$ in first order only and unresolved; and the single line $4\delta-7\phi$.

Experimental details will shortly be published.

R. J. LANG.
STANLEY SMITH.

Department of Physics, University of Alberta,
Edmonton, Alberta, Canada, July 11.

The Attraction between Homologous Chromosomes.

It has been shown that the chromosomes of *Datura* (*American Naturalist*, vol. 56, pp. 339-346, 1922), *Hyacinthus* (*Genetics*, vol. 10, pp. 59-71, 1925) and *Uvularia* (*Journal of Genetics*, in press), for example, are combined side by side, and end to end, at the reduction division. If n is the haploid number of chromosomes, this finding of partners and conjugation of chromosomes points to the presence of $2n$ different attractions. (It is easily demonstrated in *Uvularia* that homologous ends of each chromosome are opposed, for the ends of the chromosomes differ in appearance.) This is confirmed by the formation of trivalents, quadrivalents, quinquivalents, etc., in triploid, tetraploid,

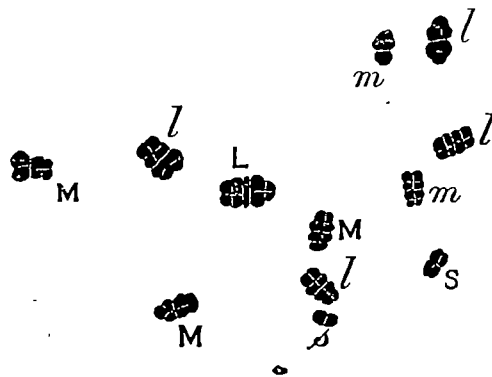


FIG. 1.—*Datura* chromosomes

and other plants with more than two homologous chromosomes; and also by the fact that none of the 12 chromosomes of the haploid *Datura* pair at the reduction division (Fig. 1). Such a number of attracting forces seems perhaps unexampled in physics.

JOHN BELLING.
Carnegie Institution of Washington.

² Trans. Roy. Soc., A, 224, 371-419

³ *Phys. Rev.*, September 1924.

⁴ Proc. Roy. Soc., June 1923.

Science in South Africa.¹

By General the Right Hon. JAN CHRISTIAAN SMUTS, P.C.

THE Wegener hypothesis purports to explain the origin, the past and the present of all the continents and oceans of this globe. But for us in South Africa it has a special interest in its account of the origin and distribution of continents in the southern hemisphere. Whether this account is correct or not, the hypothesis has the great merit of focussing attention on many great problems which call for explanation; and it has the further merit of associating these problems and making them parts and aspects of a great common scheme, instead of merely leaving them, as disjointed unconnected items, scattered haphazard over the various special sciences.

For us in this part of the world, the most interesting feature of the scheme is that in it Africa assumes a central position among the continents; it becomes, in fact, the great "divide" among the continents of the southern hemisphere; it appears as the mother-continent from which South America on one side, and Madagascar, India, Australasia and their surrounding areas on the other, have split off and drifted away, have calved off, so to speak. The evidence for all this is strong; but it may well be that the evidence is yet insufficient to account for the whole Wegener hypothesis. It may not be strong enough to prove the actual disruption and separation of the continents in the past which is the essence of the hypothesis. But even so it may be right in assigning to the African continent a central determining position in respect of many of the great unsolved problems of geographical distribution, and in making that position the key which science will have to use in ever-increasing measure if it wishes to unlock the door to future advances. The value of a hypothesis often depends not so much on its correctness as on its fruitfulness. For the present I am prepared to look upon Wegener's hypothesis as a fruitful point of view more than a solution, as a suggestive line of thought and research along which useful work may be done in the future.

One important line of research which it suggests to us is the east-west aspect in addition to the hitherto prevalent north/south line of orientation. Hitherto it is the European affiliations which have guided our thought and our research; we have looked to the north for explanations as well as our origins. In future, on the lines of Wegener's speculations, we shall look more to east and west—to our affiliations with South America, India, and Madagascar and Australasia, for the great connexions which can explain the problems of our past and present. We shall look upon southern Africa as the centre of the southern hemisphere and correlate all the relevant scientific problems of this hemisphere from that new point of view. This new aspect will establish new contacts, and it is generally such new contacts which prove fruitful and creative for scientific progress.

Let me first take the case of geology, a science in which a very high standard of success and excellence has been achieved in South Africa. A great amount of attention has been devoted to the question of the

correlation of our geological formations with those of Europe, and although many unsolved problems still remain, the main outlines of the correspondence of our formations with those of the northern hemisphere have been successfully worked out. A good deal has been done, yet quite insufficient to correlate our formations with those of South America, India or Australasia. Yet it is evident that the subject is one of profound interest, both from a scientific and a practical point of view. Several of our formations at the Cape seem to be continued or paralleled by identical or similar formations in India and South America. A proper correlation of the geological systems may lead to most interesting results, and may also throw great light on the past of the three continents. We may thereby be enabled to explain just why they are practically the sole producers of the world's diamonds, why the diamond-fields of South-West Africa are situated on one edge of the Atlantic and those of Brazil on the other; why the coal-fields of these three countries and of Australia are confined to the eastern halves of each of these land masses; and why the curious and ancient banded-ironstones are so widely spread in South Africa, Brazil, peninsular India and Western Australia, though absent from Europe. The results of such a comparative study for the southern hemisphere might be most valuable and might settle many of the problems which still agitate science as to the past of the earth.

It is when we come to the biological sciences, however, that such a comparative study promises the most fruitful results. Here there is a number of momentous problems still awaiting solution. Consider, for example, the problems affecting our botany. We have two distinct floras in South Africa; one, the South African flora which covers most of sub-tropical Africa and is clearly of tropical origin; the other, a temperate flora, found only in the south-west of the Cape Province on the seaward side of the first great mountain barrier, with outliers extending to the north along the mountain systems into the tropics. The two floras are apparently quite different and distinct and are engaged in a mortal conflict with each other, in which the temperate or Cape flora is slowly losing ground. This Cape flora forms indeed a problem of profound and baffling interest. What is its origin, and what its relation to the South African flora? The South African flora is, as I have said, clearly of tropical origin, and consists largely of subtropical derivations and modifications of the tropical forms found farther north in the equatorial regions. Can its origin be traced further back? In the answer to this question we meet again with what I may call the European fallacy, or the fallacy of the European origin. The current idea among botanists is that northern Europe is the source and the north temperate flora of Europe is the origin of both our South African and Cape floras. The north temperate flora of Europe is supposed to have been driven south by the onset of the last great Ice Age in Europe and, in the much cooler climate of the tropics at that time, to have migrated southward along the eastern mountain systems of Africa until southern Africa was reached.

¹ From the presidential address to the South African Association for the Advancement of Science, delivered at Oudtshoorn, Cape Province, on July 6.

This common view of the European origin of our floras will, however, require very careful reconsideration from the viewpoint which I am suggesting here. The correlation of our floras with the other floras of the southern hemisphere may profoundly affect this question of origins, and may throw much fresh light not only on the origin of our floras in Southern Africa, but even on so momentous a question as the origin of the flowering plants and on geographical distribution generally. Even according to our present knowledge, the African floras do not seem to fit in well with the current view of their origin. Apart from the Cape flora in the extreme south, and the Mediterranean temperate flora in the extreme north, the African flora—better known as the Tropical African flora or the Palæotropical African flora—covers the rest of the continent. In this flora an element predominates which is peculiar to this part of the world, but is more or less closely related to the floras of India, Madagascar, Australasia and South America. In other words, the special affiliations of the Tropical African flora are in the southern hemisphere. Similarly the Cape flora has peculiar affiliations with the floras of certain countries in the southern hemisphere. The current view of the northern origin may therefore not be the last word so far as botany is concerned.

On this question we have the following two interesting facts. First, the fact already mentioned that the chief types of the African flora have their affiliations in the southern and not in the northern hemisphere. Secondly, the fact that the chief types of the present Cape flora, such as the Proteaceæ, Rutaceæ, and Restiaceæ, to-day occupy the areas that correspond to the former Gondwanaland, that is to say, exactly the same area which was covered by the *Glossopteris* flora in Mesozoic times. It is alleged that some fossil types of Proteaceæ have been found in Central Europe in lower Cretaceous deposits, but these finds are disputed. These two facts would seem to point to the conclusion that the two African floras are probably of southern origin and have not been derived from the northern or European flora. Nay, more, the suggestion of Seward that the Mesozoic flora of Europe, which is markedly dissimilar from that of its Palæozoic flora, may have had a southern origin in Gondwanaland, opens up very interesting possibilities. Indeed, in the palæobotany of the southern hemisphere we are only at the beginnings, and who knows whether further discoveries in this largely virgin field of research may not yet give point and substance to Darwin's surmise that the existence far back in the long ages of an extremely isolated Southern Continent is somehow to be linked with the mysterious origin of flowering plants.

Some of the greatest problems of botany, of geographical distribution, and of the past of the earth will have to wait for their solution until palæobotany has made much further advances in South Africa and the southern hemisphere generally. In this connexion a great opportunity lies before science in South Africa. I trust a step will be taken by the establishment of a chair of palæobotany at one or other of our South African universities. It will be a small step, but its significance will be great and its results may be far-reaching.

So far I have only referred to the evidence of palæo-

botany. But the evidence of our southern palæontology generally is all in the same direction. Still more so is the evidence of the present botanical distribution throughout the southern hemisphere. The present distribution is not only strong presumptive evidence in favour either of a great Southern Continent or great land connexions in the south in the past, but also in favour of the independent origin of the African flora. Dr. Otto Stapf, whose knowledge of African grasses is unrivalled, goes even further in his masterly "*Grassenflora Sud-Afrikas*," and would seem to suggest that very special importance is to be attached to the unique character of the Cape flora as distinguished from the African flora. The Cape flora points not only to a southern origin but to an origin even farther south than the ancient Gondwanaland is commonly supposed to have extended. May we not venture the suggestion that the Cape temperate flora is the survival of an Antarctic and sub-Antarctic flora which has perished in the climatic changes of the past? That, at any rate, would account for its marked differences from our sub-tropical South African flora.

Enough has been said to show how important it is that there should be a regular comparative study of the scientific problems of the countries which lie in the southern hemisphere, with South Africa as the centre of the whole group. Such a comparative study promises rich results and will probably give a new direction and a fresh impetus to many branches of scientific work. For this purpose it seems to me not only advisable to devote more attention to palæobotany at our universities, but also essential that South African students and workers should visit other countries of our hemisphere and familiarise themselves with the scientific conditions and problems which obtain there.

Let us now pass on from biological questions to the problems of South African climate and meteorology, which I need scarcely point out are of supreme importance not only in an economic but also in a scientific sense. Here, too, we shall find that the present has its roots deep in the far-off past.

Great ice-ages are known to have occurred far back at the beginnings of geological time before the present sedimentary formations were laid down. To pass to the other extreme, Europe during the Permo-carboniferous period, when the coal measures were mostly laid down, possessed the climate of a sub-tropical rain-forest, and at a much later date the magnolia and similar tropical plants flourished in Greenland and Spitsbergen. At that time, Europe was mostly covered by shallow seas and its tropical climate was balanced by a cold dry climate which existed in the contemporaneous Gondwanaland of the southern hemisphere. The *Glossopteris* flora of the latter was the vegetation of a cold dry climate, and the glaciation of many parts of Gondwanaland, of which evidence is visible over a large part of South Africa, shows that great ice-masses must have covered its high table-land. Much other evidence points to the fact that the ancient Africa which formed the centre of Gondwanaland was on the whole a cold and arid country.

Gondwanaland must have been an unpleasant country to live in, not only because of its climate but also because of the vast geological disturbances which were gradually tearing it to pieces. Even if the tearing

asunder and drifting apart of the ancient continent according to Wegener did not take place, there must have been submergence and disappearance under the sea of great land connexions between the countries of the southern hemisphere. Other indisputable evidence of the severe and long-continued convulsions of Africa during the Tertiary times exists. The vast cracks and fissures which rent it from south to north exist to-day still in the chains of great lakes and "rift-valleys," which extend across Africa from the Zambezi to the Red Sea, the Dead Sea and the deep valley of the Jordan. Farther north the crust of the earth folded up slowly like a crumpled scroll, and as a result the huge mountain chains of the Atlas and the Alps, the Taurus and the Himalayas were formed. Volcanoes burst forth in Africa in many places along the lines of weakness, while in the south the diamond pipes were formed. During this prolonged period of change the climate of southern Africa also must have changed considerably, for instead of the cold of Mesozoic Gondwanaland, we find so far south as Kerguelen Island the remains of araucarias which must have flourished there in Tertiary times.

These far-off climatic conditions of the ancient Africa have for us of to-day only a mild scientific interest. But the remarkable changes in terrestrial climate which set in at the end of the Tertiary period are on a different footing and have produced effects which are still felt by us in the present era. A marked elevation took place in the lands of the southern hemisphere, and South Africa ended considerably farther south and nearer to the Antarctic than to-day. Then the snow began to fall and the ice to form on Scandinavia, and the glaciers and ice-fields to extend south into Central Europe. Similar conditions ensued in North America and Antarctica. The last Great Ice-Age had begun, with effects which were felt right across the equator into subtropical southern Africa. The increasing cold in the Antarctic and the subantarctic islands wiped out the entire south temperate flora with the single considerable exception of its most northern outlier in the South-West Cape, where it still survives as a unique relic of the past. The combined effects of the two northern and southern cold areas were reflected in moister conditions and greater rainfall in southern Africa during the Pleistocene than we have to-day.

Throughout the half a million to a million years which cover this period, the land level of northern Europe kept oscillating, and the Scandinavian ice-mantle was growing or dwindling, with mild or even warm interglacial periods between. It was in the last two interglacial phases that man appeared in Europe, not yet *Homo sapiens*, but earlier species of mankind. To locate ourselves properly in the frame of the geological picture we have to envisage ourselves as living in a new and mild interglacial period; we have to remember that Scandinavia is once more rising at the present rate of perhaps a metre or more per century, and that in another ten thousand years or more Europe will possibly be once more in the grip of a great ice-age. South Africa is also rising at a rate which has not yet been determined but is appreciable, our climate will gradually become cooler, until we shall again have more moist and rainy conditions than to-day; and the voices of the Schwarzes will no longer be heard crying in the wilderness which

will have passed away. We may regret that we shall not live to see that day, but that regret will be tempered by the further thought that hitherto each interglacial phase has seen the passing away of a lower species of the human genus to make way for a higher one, and that in all probability our present human races will before the next phase have had to disappear and make way for the higher species of humans which it is hoped will occupy the next age.

The factors which affect large divisions and periodicities of climate and rainfall are still a matter of controversy amongst scientists. But there can be little doubt that the formation of the great Scandinavian ice-field, partly at any rate through land elevation at the end of the Pliocene, had the most profound effect on the climate and the history of Europe and Asia during the present geological period. A great anticyclonic storm centre was thereupon established, which displaced the rain-bearing cyclonic belts and thereby produced the most far-reaching changes, which were felt even across the equator of the old world.

The Great Ice-Age in Europe appears to have synchronised with a period of greater rainfall in Africa, including South Africa. The remains of great rivers and lakes in all parts of southern Africa, and the gravel terraces in certain regions which are now waterless deserts, bear witness to the higher rainfall during the Pleistocene and to the consequent accumulation of surplus waters in the sub-continent. The Swedish geologist de Geer has by methods of remarkable ingenuity and accuracy determined that the ice-body finally retreated from Sweden about twelve thousand years ago, and this result agrees very well with the corresponding estimates obtained in North America. We may therefore take it that during the last ten thousand or twelve thousand years South Africa has been experiencing a lessening rainfall; the run-off of the rivers to the ocean has not been properly compensated for by rain. There has thus been a progressive desiccation of the land, and the arid or semi-desert conditions of to-day have probably been in existence for some thousands of years. That is the opinion of Passarge ("Die Kalahari," c. 37), who made a closer study of this question in the Kalahari region than any other worker. At the same time it has to be admitted that we are still ignorant of or in doubt about a number of matters bearing on the past rainfall of southern Africa, and important problems still await the attention of our scientific workers in this regard. Prof. Schwarz's writings have focussed much popular attention on some of these questions, but in scientific circles the matter as a whole has not yet received the attention it deserves. It is to be hoped that this omission will soon be repaired, for there can be no question either of the scientific interest or the practical economic importance of the subject as a whole.

Meteorology ought to occupy a foremost place in our activities as a State and as a country for scientific investigation. The comparative smallness and seasonal uncertainties of our rainfall make this a matter of the greatest economic importance, while our central position in the southern hemisphere carries with it peculiar advantages and responsibilities for meteorological observation and research. Yet very little pure research has so far been done. In his letter to the recent

Drought Investigation Commission. Dr. G. C. Simpson, Director of the Meteorological Office, London, makes the following grave charge against us :

Of the large land-surfaces, the meteorological conditions of Africa are probably the least known, for except from Egypt we receive practically no meteorological information from this great continent, and South Africa is probably the largest area having a settled civilised Government which publishes little or no meteorological information officially.

and he goes on to make the following recommendation :

The most hopeful method of attack on the problem of seasonal forecasts is to compare and correlate the records of various meteorological factors ; thus one of the first steps to the attainment of your object will be the formation of a strong meteorological service to gather data of satisfactory reliability from Africa itself, and probably, in connection with other countries in the Southern hemisphere, from the Antarctic continent. I do not think that one country alone should undertake to place meteorological observatories on the Antarctic continent. There should be international co-operation of the countries interested, and the aim should be to establish one or more observatories which can be kept in constant activity along a well-planned programme for an indefinite time.

Here, then, is a very valuable suggestion for us to act on. The Argentine Government has already made a start by maintaining two meteorological stations in the Antarctic, one on the South Orkneys and one in South Georgia. If the Union of South Africa and Australia could agree each to maintain an Antarctic station opposite or to the south-west of their respective territories, and the work of the four Antarctic stations could be co-ordinated, the results might be of the utmost value.

The discussion of our climate and meteorology leads me to mention the subject of astronomy and to refer for a moment to some of the outstanding contributions which have been made to it in South Africa. Here, too, our favourable situation in the southern hemisphere and our meteorological conditions, unrivalled for astronomical research, have enabled South Africa to play an honourable part in the advancement of science. Here it was that in the middle of the eighteenth century the Abbé Lacaille made the first scientific catalogue of Southern Stars. Here, too, it was that early in the nineteenth century our second Astronomer-Royal, Henderson, made the first determination of the distance of a fixed star from the earth, in the case of α -Centauri. Here it was that Sir David Gill made the classic determination of the mean distance of the sun from the earth, a determination the accuracy of which has received only additional confirmation from subsequent determinations.

The Cape is also the birthplace of many other lines of astronomical research. It was at the Cape Observatory that celestial photography had its real beginning. Previous to 1882 it was more an amusement in, than an auxiliary to, astronomy. But in that year Gill, while photographing the great comet, was struck with the power of the photographic plate to picture the faintest stars. Forthwith he conceived the idea of photographing the whole heavens, and thus the most efficient

and far-reaching arm in stellar research had its beginnings. From that day photography became the most powerful weapon in the astronomical armoury. The epoch-making departure thus happily initiated will now be further followed up in South Africa with the great resources of the United States of America. We wish the Yale Observatory at Johannesburg under Dr. Schlesinger, and the coming Princeton Observatory at Bloemfontein under Dr. Hussey, all possible success in the important tasks they have set themselves.

Let me mention a second line of astronomical research where South Africa was responsible for taking the initiative. For many years it was the home of variable star research. The first observatory in the southern hemisphere for this special branch of astronomy was built at Lovedale in 1891 by Senator A. W. Roberts. It was at this observatory that he made the first estimates of stellar densities, as well as the earliest determinations of close binary systems and their evolution. This pioneer work has led to most important developments in astronomy which are now rapidly revolutionising our views as to the origin and evolution of the material universe. On all these grounds the record of South Africa in astronomical research is indeed one of outstanding distinction ; and there is no reason why this record should not be maintained for the future in this land of clear skies, of equitable climate, of peaceful days and cloudless nights, where an endless attraction and a rich promise are continually held out to the lover of the heavens.

I now pass on to the last science which I shall refer to as one to which South Africa should, from its central position, be able to make a great contribution in the future : I refer to human palæontology. Three finds of outstanding importance have in recent years signalled South Africa as a great field of research into the human past. The first was the discovery of the Boskop skull, which traced the Strandlooper and Hottentot peoples of South Africa to their prehistoric ancestry. The second was the discovery of *Homo rhodesiensis* at Broken Hill, which Prof. Elliot Smith is reported to have declared one of the most significant finds ever made in human palæontology because by that discovery Africa for the first time realised our firm expectation of providing extinct types of the human family that present problems of exceptional interest. Finally, we have *Australopithecus africanus*, which largely breaks new ground in palæontology.

In *Australopithecus africanus* we have a transitional form between the ape and the human ; we have a creature which is still indisputably an ape, but with certain facial features and a brain development which take it some way towards the human. Looking upon the human and the ape forms as the two extremes which will have to be bridged by palæontology, we note that this can be effected in either of the two ways. We may find fossil forms carrying the human further back into its human or prehuman past, or we may find fossil forms carrying the ape form forward towards some intermediate point on the road towards the human. The Broken Hill skull has done the first, and the Taungs skull has done the second. Together they form an outstanding contribution to the elucidation of a most difficult but most fascinating problem of anthropological science.

It is a remarkable fact that *Homo rhodesiensis*, although apparently a more primitive and simian type than *Homo neanderthalensis*, was found still unfossilised, and among animal remains which belong to still living Rhodesian species. The deduction has been made that *Homo rhodesiensis* was living quite out of his proper geological horizon, and was surviving in South Africa long ages after his compeers in Europe had passed away. In fact he was probably still flourishing in the south when his European "contemporaries" had been dead for thousands of years. But there is really nothing singular in such an idea. After all, such a situation is typical of South Africa in more respects than one. Our Bushmen are nothing but living fossils whose "contemporaries" disappeared from Europe many thousands of years ago. The interest of South Africa as a field for anthropological research is partly just this, that it is possibly ten thousand years behind the times, as measured by the standards of European cultures. In this respect our anthropology does not stand alone, for in botany also we have true "living fossils" like the cycads. In South Africa, therefore, certain biological problems can still be studied from life which in Europe can only be deduced with difficulty from the fossil records of the past.

That is by no means, however, the only or the best claim that South Africa can put forward as a fitting place for palaeontological study and research. Discoveries already made point to the possibility that South Africa may yet figure as the cradle of mankind, or shall I rather say one of the cradles? As we have seen, it is not only one of the oldest land surfaces but

also, since the end of the Mesozoic period, it has generally enjoyed a fairly habitable though, on the whole, dry climate. While in Tertiary and Pleistocene times most of Europe and much of Asia and North America were intermittently under ice or shallow seas, southern Africa was very much as it is to-day. No wonder, therefore, that it should contain some of the most ancient fossil records of the human race, and that among its living races it should include what are "fossils" in other continents. Its little Bushmen are unique; its little pigmy population that hide in the tropical and subtropical parts are the representatives of the long-vanished human past. Going a little further back, we find in Africa the home of the great anthropoid apes which are nearest to us in the affinities of life. Here then we are clearly near to the great origins. These and other considerations point to the vast importance of Africa from a palaeontological point of view, if not to the possibility that here may yet be found some intimate connexion with the far-off beginnings of the human race. The scope for scientific work in South Africa in this department of knowledge is therefore immense.

Science has in South Africa a splendid field of labour: other nations may well envy us the rich ores of this great "scientific divide" which is our heritage. I trust that South African science will rise to the height of its great opportunities, and that this sub-continent will yet earn for itself that scientific leadership of the southern hemisphere to which its central position and its great scientific assets and opportunities entitle it.

The Crystalline Structure of Inorganic Salts.¹

By Prof. W. L. BRAGG, F.R.S., Langworthy Professor of Physics, University of Manchester.

THE examination of crystalline bodies by means of X-rays has enabled us to discover the positions of the atoms in the crystal. In the earlier period of X-ray analysis it was only possible to do this when the atoms were arranged according to a simple pattern of high symmetry. Experience has increased the range of substances to which the new methods can be applied, and we can now assign structures to relatively complex crystals, basing the proposed structure on the manner in which the crystal diffracts the radiation.

The study of the crystalline structure of organic and inorganic compounds has revealed certain broad distinctions between these two classes of crystals. The crystalline arrangement throws new light on those differences in the structure of the molecule which have made it convenient to distinguish organic from inorganic chemistry. No exact line can be drawn between the two classes of crystals, and yet the main features are sufficiently different to make the classification useful. The organic crystal appears to be composed of definite molecules. Inside each molecule the atoms are bound together by forces so local, and so rigid, that an addition to one part of the molecule scarcely affects the rest; these molecules are then massed together by comparatively weak forces into a crystalline structure. The form of the inorganic

crystal suggests that the bonds between atom and atom are not limited to certain directions; the molecule is more fluid, and an addition to one part profoundly disturbs the relationship of all the rest. It must be this molecular fluidity which makes it so hard to apply the ideas of stereochemistry to inorganic compounds although they have been so successful in explaining the organic compounds.

Our powers of X-ray analysis are as yet very incomplete and it is difficult to find the positions of the atoms in complex structures. The complexity of a structure depends on the number of parameters, or degrees of freedom permitted by the symmetry, which fix the positions of the atoms in its pattern. At the present time any structure with more than half-a-dozen of these independent parameters presents a difficult problem. Crystals with two or three parameters are comparatively simple. For several reasons the inorganic salts can be analysed more completely than organic compounds. In the first place, the number of atoms in the inorganic molecule is generally smaller than that in the organic molecule, and owing to the power of readjustment in the former class of compound which has already been mentioned, the atoms often take up a symmetrical arrangement and this symmetry makes the X-ray investigation more easy. Every requirement of symmetry which must be satisfied by the atom reduces the number of variable

¹ Discourse delivered at the Royal Institution on Friday, May 1.

parameters in the structure, and confines the atom to certain planes, lines, or points from which it cannot move. Further, in a series of inorganic crystals it is often possible to replace one atom by another of similar chemical properties without altering the crystalline structure. Now the heavier atoms scatter X-rays more than the lighter atoms. If, therefore, we wish to find the position of the metal atoms in an inorganic salt, and a crystal of the series is available in which the metal has a high atomic weight compared with the other constituents, it is an easy matter to fix its position. The same process can often be carried out with a heavy atom in the acid radical and a light one in place of the metal. In order to aid the X-ray examination we are using a method which is precisely like the staining, by means of suitable dyes, of certain parts of a microscopic preparation. In the organic crystal the atoms of carbon, oxygen, and nitrogen are almost indistinguishable by means of X-rays since they are so close in the periodic table, and, with the exception of one or two compounds, it has so far been impossible to fix their positions.

The inorganic salts are interesting not only because we know more about their structure, but also because they lend themselves more readily to mathematical treatment. We may compare this case of crystal equilibrium to the engineering problem of calculating the stresses to which the members of a girder system are subjected. If the number of constraints is the minimum requisite for rigidity, these stresses can be directly calculated by simple laws of mechanics. If the whole structure is too rigid, much more detail must be known about the structure in order to calculate the stresses. The inorganic crystal represents the structure with the minimum number of constraints. We can try to explain the properties of the crystal as a whole by making certain simple assumptions about the forces between the atoms. It is certain that the real atomic properties are more complex than those represented by these simple assumptions, but it is interesting to see how far one can get towards an explanation with their aid. For example, a number of crystalline properties can be explained by assuming an atomic model of the following kind.

(a) The atom consists of a symmetrical electronic structure surrounding the nucleus in which the charges on the electrons and on the nucleus do not balance, so that the sum of the charges is sometimes positive, sometimes negative.

(b) When the atoms approach within a certain distance of each other a force of repulsion between their outer electronic structures sets in very rapidly and prevents closer approach.

(c) When the atom is placed in an electric field it becomes polarised. Its positive and negative parts are drawn in opposite directions and it is surrounded by a field like that of an electrical doublet.

With the aid of these assumptions, qualitative explanations have been given of the formation of inorganic compounds (Kossel) and quantitative explanations of the heats of formation, heats of solution, latent heats of evaporation, and elastic properties of the inorganic crystals (Born and Landé, Madelung, Fajans, and others). Their highly interesting investigations have been applied to crystals of a symmetrical and

simple type, such as the rock-salt structure. The quantitative agreement between calculated and observed data is most striking and shows that the assumptions which have been made are not far from the truth. I do not wish to discuss their results here; I quote them to show how far this atomic model explains the facts, as I wish to use it in examining the more complex salts which we have analysed by X-rays.

The force which causes two atoms to repel each other when they approach closely is very interesting. We do not know its origin, but it is clear that it sets in very sharply and increases rapidly as the centres of the atoms get closer together. This is so much the case that each atom in the crystalline structure appears to be surrounded by a domain which it occupies to the exclusion of other atoms. We cannot define the size of this domain exactly because the distance of closest approach of two atoms will always depend on the strength of the force driving them together, but the domain varies within narrow limits for the range of forces ordinarily present in a crystal. A knowledge of the domain associated with the atoms and molecular groups is most important in crystal analysis since it limits the possible configurations and confines the atoms to certain regions where they do not overlap too greatly. In a Friday evening discourse at the Royal Institution four years ago, I gave some empirical figures for the radii of these atomic domains and tried to show how these figures could be used to aid crystal analysis. I wish to take this opportunity of saying that I have considerably altered my views on this question; other workers who have dealt with the subject have given alternative estimates of the domains, which I believe to represent the physical facts far better than did my original figures, and in addition a more complete knowledge of crystal structures has shown how elastic the atomic domain is and what care is necessary in using the conception to help analysis. Nevertheless, its very great importance must not be lost sight of, for it is one of the principal aids we have in tackling a difficult crystal structure.

We do not know the exact dimensions of the electronic orbits, but such estimates as can be formed suggest that in a crystal such as rock-salt there are large spaces between the outermost orbits of neighbouring atoms. Each atom has its system of orbits quite distinct and widely separated from those of its neighbours. This is generally true where the charged atoms are of a symmetrical type and held together by electrostatic attraction. On the other hand, where the chemical evidence points to a linkage of the homopolar type, crystal analysis shows the atoms close together as if the electronic orbits were actually linked up.

A series of atomic structures such as O^{--} , F^- , Ne , Na^+ , Mg^{++} , Al^{+++} are supposed by Kossel to have a common configuration resembling that of neon itself. The charges on the atoms are due to the addition or removal of electrons required to give them the correct number for a neon structure. The scale on which the atoms are built must diminish from oxygen to aluminium, owing to the increasing nuclear charge, Al^{+++} being on about one-half the scale of O^{--} . The idea of an atomic domain can only be a very rough approximation to the truth, for in actual fact there must be a different law of force for

every given pair of atoms; in this approximate sense, interatomic distances in simple crystalline structures are in agreement with the supposition that they obey an additive law and that the dimensions of the domain are proportional to those of the atomic structures in a series such as has been given above. I directed attention to this additive law as an empirical fact in the discourse referred to above, but made the domain of the positive ions too large and those of the negative ions too small. A better interpretation of the significance of the law was given by Wasastjerna in a paper on the "Radii of Ions" in which due weight was given to the relative dimensions of the electronic structures. Recently, Jones, in a series of highly interesting papers, has linked up the fields which give the repulsion between atoms of an inert gas, and the fields of the corresponding ionic structures in crystals.

Again, in the case of the very simple crystals, good quantitative agreement between calculation and observation of crystal dimensions can be obtained by certain simple assumptions about the nature of the repulsive field due to their electronic structures. In the more complex crystals the concept of an atomic domain is by itself sufficient to explain the general configuration of the crystal. Cases which are especially interesting are those where the domain of one ion is much larger than that of the other. The structure of aluminium oxide, Al_2O_3 , is an example. Since the oxygen ion is so much larger than the aluminium ion, the structure is that of a series of oxygens in a close-packed arrangement (hexagonal) with aluminium atoms in the interstices acting as a cement to bind the whole together. In spinel, MgAl_2O_4 , the oxygen atoms are in a cubic close-packed arrangement. In cadmium iodide, CdI_2 , the large iodine atoms are in hexagonal close-packing with cadmium atoms lying between alternate layers perpendicular to the hexagonal axis. Tin tetraiodide is another case where a quite complex structure approximates closely to a cubic close-packed arrangement of iodine atoms. Such crystals give a great deal of information about the forces between atom and atom.

In a few cases it has been possible to determine the shape of the acid radical. In CO_3^{--} and NO_3^- the oxygen atoms are arranged at the corners of an equilateral triangle around the central atom, and the arrangement must be very nearly the same in ClO_3^- . Though we do not know the arrangement of the oxygen atoms round the sulphur atom in SO_4^{--} with such certainty, they must be nearly at the corners of a

regular tetrahedron, and the arrangement also holds in such groups as ClO_4^- , MnO_4^- , SeO_4^{--} . In an ion such as PtCl_6^{--} Wyckoff has shown that the six chlorine atoms are arranged at the corners of a regular octahedron around the platinum atom. The simple geometrical shape in each case is interesting, and it is difficult to avoid the conclusion that the outer atoms are all related in the same way to the inner one. Kossel regards the inner atom as having a large positive charge, and holding the negatively charged outer atom by electrostatic attraction. Although the actual bonds may be of a more complex type, it is interesting to see how much this idea explains. The dimensions of the group are in accord with the idea that the large oxygen ions are grouped around a relatively small atomic structure with a high positive charge in the centre, and that the size of the group is mainly determined by the repulsive forces between the oxygens. Certain optical properties can be explained by the same conception. The refractivity of the acid group is got by assigning a value of about 3.3 to the ionic refractivity of each oxygen, and a very small value to the central atom. The strong negative double refraction of carbonates and nitrates, where the groups of oxygen atoms lie in parallel planes, is explained quantitatively by the influence on each other of the oxygen atoms arranged in a triangle. On the other hand, most sulphates have a very small birefringence. This may be explained by the regular tetrahedral arrangement of oxygens around the sulphur, for such a group on account of its symmetry is optically isotropic.

The problem of the other type of binding between atoms, in which the electronic structures seem to fuse together so that the atoms approach each other closely and are rigidly connected, has yet to be solved. In acid groups such as CO_3^{--} and SO_4^{--} the atoms may retain separate electronic systems, or the other type of binding may have come into play. In any case the atoms must be greatly distorted by their unsymmetrical location. X-rays can only tell the positions of the atomic centres, the skeleton of the structure, since the interference between waves scattered by the electrons is so complex. The centres can be fixed with considerable certainty, however, and cases of undoubted homopolar combination can be examined. The interest of the inorganic structures lies principally in the fact that they can be analysed with some degree of completeness, and it is to be hoped that they will tell more about the binding forces. They present a fascinating series of problems for solution.

Southampton Meeting of the British Association.

LOCAL ARRANGEMENTS.—II.

VISITING members of the British Association are requested to book for Southampton West Station, where men wearing distinctive armlets will be in attendance on the station platforms to render assistance to members on arrival and to afford information. The idea of a special train from Waterloo on the Tuesday, the day before the opening of the meeting (as previously announced), has been dropped because the existing means of communication to Southampton, on further examination, were found to be amply sufficient. Baggage may be deposited at

the Reception Room if desired for conveyance to the address in Southampton where the member will be staying. Tickets of membership may be obtained at the Reception Room.

The Reception Room is at King Edward VI. Grammar School in the Marlands, two minutes' walk from the West Station. Here the following facilities will be provided for members: ticket and information bureau, where a representative of the Southern Railway will be in attendance; telephones; smoking and writing room; ladies' rest rooms; post office;

exchange of communications between members; cloak room; press bureau; bookstall; administrative rooms, etc.

The official restaurant for the meeting will be the Coliseum, situated in Portland Terrace, three minutes' walk from the Reception Room. Special arrangements have been made with Messrs. Price Bros., caterers, for the convenience and advantage of the members. Luncheons and teas will be available. For the convenience also of members of the sections meeting at the University College, Highfield, the College refectory will be open for lunches and teas.

Rest rooms for ladies have been very kindly provided at each of the following houses: (1) Y.W.C.A. in Portland Terrace; (2) The "Barova Restaurant," at Messrs. Tyrrell and Green, Ltd., Above Bar Street near the Junction; (3) Messrs. E. Mayes and Son, Ltd., 173-178 High Street, below the Bargate; (4) The Central Hall, at the bottom of East Street. Accommodation for both ladies and gentlemen will also be available at the Central Hall. An excellent and well-illustrated booklet, "Southampton and the New Forest," compiled by Messrs. Russell and Co., will be presented to each member. Therein on p. 5 will be found a street map of Southampton, and likewise on p. 75 a full list of places of worship.

Badges, which members are particularly requested to wear on all occasions, will be handed them at the Reception Room, and will prove most valuable for identification of membership. The Corporation Tramways Committee has generously decided to extend the privilege of free use of the tramcars and omnibuses of the municipality to members during the period of the meeting.

The Royal Southampton Yacht Club, the Constitutional Club, and the Portswood Conservative Club have kindly offered honorary membership during the week to all members of the Association; while the Rotary Club of Southampton invites all visiting Rotarians to the luncheon on the Friday in the South-Western Hotel, and the Masonic Lodges of the town have offered to their brethren in freemasonry and their ladies a reception at the Chantry Hall on the Monday, when afternoon tea will be served. A civic reception will be given by His Worship the Mayor and the Mayoress of Southampton at the Pavilion, Royal Pier, on Thursday evening at 8 o'clock, and it is hoped that members will make a point of attending this function. A reception will be given by Lord and Lady Swaythling at their mansion, Townhill Park, on Sunday, August 30, at 8 P.M., when a special omnibus service will be run in connexion with the event. Garden parties will be given by Lord and Lady St. Cyres at Walhampton near Lymington on Friday, August 28, at 3 P.M., and on the same afternoon by Sir John and Lady Power at Newlands Manor near Lymington, New Forest.

The Cunard Co. has very generously invited the British Association to visit the R.M.S. *Aquitania*, and have tea on board on Friday, August 28; the White Star Line has extended a similar invitation, to the R.M.S. *Majestic*, on Monday, August 31; while Commander C. B. Fry has thrown open for inspection the Training Ship *Mercury* on the Hamble River on Saturday, August 29, at 3.30 P.M.

Invitations for parties from the British Association to see over their works have been received from the following firms: The International Cold Storage and Ice Co., Ltd., the Docks; Pirelli General Cable Works, Ltd.; Auguste Pellerin, Ltd. ("Le Dansk" Margarine Factory); The Southern Railway Co. for the Docks; Messrs. Harland and Wolff, shipbuilders, the Docks; The Ordnance Survey Office, The Avenue; Messrs. Toogood and Sons, seedsmen.

Two organ recitals have been arranged to be given in the New Central Hall: (1) a grand organ recital on the Saturday, August 29, at 7.45 P.M. (admission 6d.), when a large number of seats will be specially reserved for members of the Association; (2) a special organ recital on the Sunday afternoon, August 30 (admission free), from 3 to 4.15 P.M. This performance will be broadcasted by the British Broadcasting Co. and all members of the British Association are heartily invited.

General excursions have been arranged as follows:—

Thursday, August 27.—Messrs Toogood and Sons, Ltd., Seed Warehouse, "Blighmount," Millbrook, at 3 P.M.; Pirelli, Ltd.; Cable and Tyre Works, Western Esplanade, at 2.30 P.M.

Friday, August 28.—The s.s. *Aquitania*: invitation from the Cunard Co. to inspect the vessel and have tea on board, 3 to 5 P.M.; New Forest trip, including garden party, by Lord and Lady St. Cyres, at Walhampton, near Lymington, at 3 P.M. (on the return journey, Beaulieu Abbey and House will be visited by invitation from Lord and Lady Montagu); New Forest trip, including garden party, by Sir John and Lady Power, at Newlands Manor, Lymington, at 3 P.M.; Ordnance Survey Office, The Avenue, Southampton, 2 to 4 P.M.

Saturday, August 29.—Isle of Wight (whole day): by steamer to Cowes then motor via Newport, Sandown, Ventnor, where lunch will be served, Alum Bay, Carisbrooke, where tea will be had, and back to Cowes; Stonehenge (whole day): via Romsey and Salisbury, returning by Winchester; T.S. *Mercury* on the Hamble River by steamer (leaving at 2.30 P.M.) down Southampton Water; Winchester: leaving at 2.30 P.M., half day excursion.

Sunday, August 30.—Reception at Townhill Park by Lord and Lady Swaythling at 8 P.M.

Monday, August 31.—The s.s. *Majestic*: invitation from the White Star Line to inspect the vessel and have tea on board, 3 to 5 P.M.; Auguste Pellerin, Ltd., "Le Dansk" Margarine Factory, Northam, at 2.30 P.M.; Southampton Gaslight Co., Ltd., tea at 3.30 P.M. at the works; Ordnance Survey Office, The Avenue, Southampton, 2 to 4 P.M.

Tuesday, September 1.—General visit to Southampton Docks at 2.30 P.M.; Messrs Harland and Wolff's Ship Repairing Works, the Docks, at 2.30 P.M.; the International Cold Storage Co., Ltd., the Docks, at 3.30 P.M.; Goughs Ice Co., Ltd., Canute Road, Southampton, at 5 P.M.; Ordnance Survey Office, The Avenue, Southampton, 2 to 4 P.M.

The following sectional excursions have been arranged:

Thursday, August 27.—K, Hythe and Beaulieu; G, Southampton Docks; K (Forestry Subsection), Messrs. Howard Bros. Timber Yard, Northam; C, The Ordnance Survey Office, The Avenue, Southampton.

Friday, August 28.—L, South Stoneham House, (garden party); E, Portsdown Anticline; G, Southampton Waterworks at Otterbourne; C, Bournemouth.

Saturday, August 29.—C, Isle of Wight (whole day); D, Beaulieu via Southampton Water and the Solent (whole day); K, Meon Valley and Portsdown (whole day); H, Salisbury and Stonehenge (whole day); M, Sparsholt Farm Institute (whole day).

Sunday, August 30.—C, Lulworth Cove (whole day); K, New Forest (whole day); L, Winchester.

Monday, August 31.—D, Hayling Island; E, Northern Part of the New Forest; G, Calshot Aerodromes and the Agwi Petrol Works at Fawley; I, Antigas School at Tipnor; K (Forestry Subsection), Durley Saw Mills (Messrs. F Houghton, Ltd.); B, Holton Heath Cordite Factory.

Tuesday, September 1.—D, New Forest; G, Railway Works at Eastleigh; G, Supermarine Aviation Works, Southampton; G, Avro Works at the Hamble; K, Hurst Castle; M, Fruit Farm, Botley; I, Fort Grange Aerodrome, Gosport; C, Hordle and Barton.

The evening discourse will be given by Mr. R. V.

Southwell on "Aeronautical Problems of the Past and of the Future," at 8 P.M., in the Central Hall, on Friday, August 28. Citizens' lectures have been arranged as follows:

(1) Major A. G. Church, on Thursday at 7.30 P.M., on "Science and the East African Commission" at the Central Hall; (2) Prof. E. V. Appleton, on Saturday at 8 P.M. at the Avenue Hall, on "The Role of the Atmosphere in Wireless Telegraphy"; (3) Capt. P. P. Eckersley, on Monday at 8 P.M. at the Central Hall, on "Some Technical Problems of Broadcasting"; (4) Mr. C. J. P. Cave, on Tuesday at 8 P.M. at the Central Hall, on "The Highway of the Air."

Lectures for Young People at the Central Hall are arranged as under:

(1) Dr. F. A. Dixey, on Saturday at 3 P.M., on "Mimicry in Relation to Geographical Distribution"; (2) Mr. W. H. Barker, on Monday at 3 P.M., on "The Development of Southampton in Relation to World Commerce"; (3) Prof. W. J. Dakin, on Tuesday at 3 P.M., on "Whaling in the Southern Ocean."

W. RAE SHERRIFFS.

Current Topics and Events.

PROF. J G MCKENDRICK, F.R.S., the distinguished emeritus professor of physiology in the University of Glasgow, reached the age of eighty-four years on August 12; Sir William Tilden, F.R.S., eminent as a chemist, celebrates his eighty-third birthday on August 15. The former was born at Aberdeen and educated there at the University. For thirty years he was professor of physiology in the University of Glasgow; he was sometime Fullerian professor of physiology at the Royal Institution and president of Section I (Physiology) of the British Association. At the Oxford meeting, in 1894, of the British Association, he exhibited and demonstrated a working model intended to illustrate the mechanism of the cochlea. With Dewar and Ramsay he conducted researches on the physiological action of the chinoline and pyridine bases. Sir William Tilden, a Londoner, was a science master at Clifton College, 1872-80, leaving to take up the chair of chemistry at Mason College, Birmingham, a post which he held for fourteen years. On leaving Birmingham he became professor of chemistry at the Royal College of Science, London, retiring in 1909. He was awarded the Davy medal of the Royal Society in 1908. In organic chemistry he has made highly important researches on the terpenes, for example, on the hydrocarbons from *Pinus sylvestris*, and on terpin and terpinol. Author of many scientific memoirs, he has also published several well-known chemical manuals.

THE report of the Electricity Commissioners in Great Britain for the year 1924-1925, which has just been published, is of considerable interest. In public supply undertakings the output for the year is 7415 million units, which is an increase of about 16 per cent on the output of the preceding year. In private plants the output would probably be about half as much. The increased output has been obtained at an appreciably higher efficiency. Last year the

average coal rate per unit generated was 2.53 lb. In the two preceding years it was 2.67 and 2.78 lb. respectively. This steady progress is satisfactory but there is plenty of scope for improvement. The new Barton station at Manchester shows the highest efficiency, namely, 1.51 lb. of coal per unit generated, and its thermal efficiency is practically twenty per cent. The coal consumption at the gas producer stations ranges from 1.81 to 3.69 lb. per unit generated, the average being 2.60 lb. per unit. The largest Diesel engine oil-driven station (1940 kilowatts) has a thermal efficiency of 26.6 per cent. For small stations internal combustion engines are the most efficient. Water power only contributes about 0.7 per cent of the total supply of electricity in Great Britain. Several large plants are now being constructed, but the total possible water power is, unfortunately, small.

THE transmission of photographs by means of telephone circuits has recently been perfected to so great a degree that the picture as received is practically a perfect reproduction of the original and shows no signs of the process of transmission. The principle of the method is well known, namely, two cylinders, one at each end of the circuit, rotating synchronously and moving axially so that a spiral line 0.01 in. wide is made to cover the surface dealt with. The sending cylinder has within it a photo-electric cell; the photograph in the form of a transparency or film is attached to the transparent surface of the cylinder, and a small spot of light falls upon the photograph so that the illumination of the photo-electric cell and the current produced are proportioned by the density of the photograph. The current produced is too feeble for transmission, therefore it is amplified, and then, by means of a vacuum tube modulator, imposed on a high frequency carrier current. At the receiving end the current passes through a narrow flat conductor which covers a small hole and is deflected by the current,

opening the hole more or less according to the strength of the current. Light passes through this hole and impinges upon a sensitive film carried on the surface of the rotating cylinder. The exposed film is developed as usual. Mr. Mervyn Thompson states (*British Journal of Photography*, July 24, 439) that a 7×5 inch photograph is transmitted in $7\frac{1}{2}$ minutes irrespective of the distance, which may be, for example, from San Francisco to New York, which is more than three thousand miles.

DR. S. E. SHEPPARD, of the Eastman Kodak Company's Research Laboratory, has succeeded in identifying the constituent of gelatine that enables it to confer the extraordinary sensitiveness on silver bromide in the modern photographic dry plate, and gives an account of his work in the *Royal Photographic Society's Journal* for August. Four emulsions prepared by the same method but with different gelatines were found to be almost identical except in sensitiveness, the fastest being about nine times as fast as the slowest. Evidently some gelatines are much more "photographically active" than others. Mr. R. F. Punnett found that an extract might be prepared from an "active" gelatine, which, when added to a relatively inert gelatine, rendered it active, and the question was to find this active ingredient. It was found that the acid deliming liquors used in the preparation of gelatine contained it, and several thousand gallons were treated for its extraction. "Gelatine-X," as Dr. Sheppard calls it, was found also in many plant materials, especially in black mustard seeds. It was now closely identified with either allyl mustard oil or allyl sulphide. Tests of various allyl compounds showed that the sensitising power was not due to the allyl group, though "gelatine-X" was finally proved to be allyl isothiocyanate (allyl mustard oil) or allyl thiourea. Active gelatines were found to contain about one part of the organic compound in from 300,000 to 1,000,000 parts of gelatine. It is this substance that produces the sensitivity centres, that is, the points where development starts, in the particles of silver bromide, and these sensitivity centres consist of silver sulphide, though allyl sulphide itself was found to be inactive. Certain selenium and tellurium compounds are effective sensitisers and give sensitivity centres that consist of silver selenide and telluride. Further details of this important discovery are to be published later.

IN our issue of March 7, p. 346, a note appears which deprecates the too sanguine statements made by politicians about the possible economies that can be effected by erecting very large electric generating stations. To illustrate this we quoted with approval several statements made by S. S. Wyer in a report published by the Smithsonian Institution of Washington, in which a comparison is made between the systems adopted on the Canadian and on the American side of the Niagara Falls. We also quoted a statement made by Mr. Wyer that the service in Ontario is not taxed, so that the lowering of the cost to the consumer is done at the expense of the tax-payers of the districts in which the property is located. Naturally

we thought that a statement of this gravity would not be made in a publication of the Smithsonian Institution unless all the facts of the case were known and had been studied. We have received a letter from Sir Adam Beck, the Chairman of the Hydro-Electric Power Commission of Canada, dated July 20, in which he states that Mr. Wyer's assertion is unfounded. He also sends us a pamphlet entitled "Misstatements and Misrepresentations derogatory to the Hydro-Electric Power Commission of Ontario contained in a report published by the Smithsonian Institution entitled 'Niagara Falls: its Power Possibilities and Preservation,' under the authorship of Samuel S. Wyer, examined and refuted by Sir Adam Beck." He states categorically that the Power Commission pays taxes both to municipalities and to the Provincial Government to the extent of hundreds of thousands of dollars annually.

THE Soviet authorities issue a Weekly News Bulletin of the U.S.S.R. Society of Cultural Relations with Foreign Countries, and a recent issue suggests great activity. Active preparations are being made to celebrate the bicentenary of the Russian Academy of Science on September 5-14 in Leningrad and Moscow. According to the programme which has been issued, the celebrations will commence on the evening of September 5 with a reception in the rooms of the Academy of Science at Leningrad. On September 6 there is to be a meeting in the grand hall of the Academy, followed in the evening by a banquet. The morning of September 7 is to be devoted to visits to the scientific institutes of the Academy, while on the following day the observatory at Pulkovo and other institutions around Leningrad will be inspected. On September 9 the Soviet Government will receive the delegates. After further visits and festivities the delegates will leave on September 10 for Moscow, arriving the next day in time for a reception at the Institute of Physics. September 12-13 will be devoted to a meeting at the Conservatoire and to visits to the museums at the Kremlin and to scientific institutes in Moscow. The celebrations conclude on September 14 with a luncheon given by the "Maison des Savants." In connexion with the celebrations, the authorities are issuing the unpublished works of Lyapunov on mathematics and physics, the syntaxis of Shakhmatov, and the Osset dictionary of Miller, which should be a very valuable publication. It is a matter for regret that there must be scores of other important works and papers, which have been lying in manuscript for years, for want of funds. The Bulletin referred to above gives some quite interesting brief outlines of archaeological work in various parts of Russia, and states that a number of scientific expeditions are being sent to some of the lesser known parts of the country.

WE have received a long letter from Dr. C. G. S. Sandberg in reference to the notice of his book, "Geodynamische Probleme," in *NATURE* of May 23, p. 791. He wishes it made clear that the pressures which, according to his view, produce earth movements, are not and cannot be lateral, but are hydrostatic, as

they are due to vapour tension. He remarks that Alpine and other similar folding has, according to his theory, been caused by vapour tension hydrostatic pressure, which, finding relief in the directions of least resistance, convey the impression of having been brought about by lateral tangential pressure. Dr. Sandberg also remarks that the diagram from Lugeon, which was reproduced in his book, was inserted to demonstrate the inseparable relation between tectonic structure and metamorphism; and the remark in the review that such diagrams, whatever may be the ultimate cause of the pressure, indicate that the actual movements are due to lateral compression, is an argument of the reviewer's, and not of Dr. Sandberg. Dr. Sandberg also points out that he does not deny some contraction in the earth as a whole, but emphatically rejects the so-called contraction theory.

THE sixty-second annual meeting of the British Pharmaceutical Conference was held in Glasgow on July 27-30. In his address, entitled "Recent and Coming Developments in British Pharmacy," the chairman, Mr. E. White, dealt with the present and future problems of pharmacy both on the educational and administrative side. He gave some account of the proposals of the Pharmaceutical Society to found a laboratory for the physiological testing of drugs, and emphasised the need for such a laboratory. He also referred to the results achieved in the recent deliberations of the International Federation at Lausanne. In speaking of proprietary medicines, Mr. White said that this had been discussed at the Lausanne Conference, and gave it as his opinion that legislation on this subject would not be long delayed; he considered that the Pharmaceutical Society must take an active part in the initiation of such legislation. Mr. White then spoke of the meeting of the International Conference to be held in Brussels in September, when the standardisation of potent drugs will be considered, and referred to the great advantage to be gained by an international agreement on certain cardinal points in the practice of pharmacy. Mr. White said he believed that a serious effort to unify pharmacy in the English-speaking communities would yield encouraging results. In the Science Section of the Conference, nineteen papers were communicated. Among these were papers on the picrotoxins of the opium alkaloids, on the identification of alkaloids and of drugs containing tannins, on the chemical examination of the oleo-resin of Indian valerian root, and on West Australian sandal-wood oil.

At a recent meeting of persons interested in the Peking Union Medical College, which is financed by the China Medical Board of the Rockefeller Foundation, an organisation called the Yu Wang Fu Association was formed. It was decided that the purpose of the Association shall be, by frequent informal meetings, to stimulate good fellowship and to continue and increase interest in the welfare of the College in those who have at any time or in any capacity worked in Peking in connexion with it, and have now entered other pursuits. Dr. Franklin C. McLean, the organiser

and first Director of the College, was elected president, Dr. E. V. Cowdry, secretary-treasurer, with Dr. A. B. Macallum, Dr. Charles Packard, and Dr. Donald D. Van Slyke, members of the council. It is intended to establish branches of the Association, of which New York is the headquarters, wherever such may be justified, but particularly in Chicago, San Francisco, London, Tokyo, and Shanghai. The first meeting of the Association will be held at the Marine Biological Laboratory, Woods Hole, Massachusetts, on August 1, when an address will be delivered by the secretary of the Rockefeller Foundation, Mr. Edwin R. Embree. Those wishing to join the Association are requested to communicate with Dr. E. V. Cowdry, at the Rockefeller Institute, 66th St. and Avenue A, New York.

ON July 12 a new Geophysical Observatory at Jakutsk ($\phi = 62^{\circ} 01'$, $\lambda = 129^{\circ} 43'$ from Greenwich) commenced work. Organised by the Geophysical Central Observatory, Leningrad, the new observatory represents a local branch of the Central Observatory and consists meanwhile of two sections, dealing with meteorological and the aerological work respectively. It is expected that in due course the observatory will be equipped for actinometric, optical, and magnetic observations.

SIR CHARLES S. SHERRINGTON, Waynflete professor of physiology in the University of Oxford, has been appointed a member of the Medical Research Council as from September 30 next. The vacancy is caused by the retirement of Dr. Henry Head, who leaves the Council under the provisions of the Royal Charter governing the rotation of membership.

THE Council of the Royal Meteorological Society has awarded the Howard Prize for 1925 to Cadet H. W. Barnett of S.A.T.S. *General Botha*, South Africa, for the best essay on "Icebergs: their Distribution and Drift."

THE following committee has been appointed "to advise as to the proper scope of the Broadcasting Service and as to the management, control, and finance thereof, after the expiry of the existing licence on December 31, 1926": The Earl of Crawford and Balcarres (chairman), Lord Rayleigh, Lord Blanesburgh, The Right Hon. Ian Macpherson, The Right Hon. W. Graham, Sir Thomas Royden, Dame Meriel Talbot, Sir Henry Hadow, Captain Fraser, Mr. Rudyard Kipling, with Mr. W. E. Weston, of the General Post Office, as Secretary.

ON Monday, August 10, the national memorial to Capt. R. F. Scott and his four companions who died on the return journey from the South Pole early in 1912, was unveiled on Mount Wise, Devonport. A memorial fund was opened in 1913 by the Lord Mayor of London, and the response has been so generous that, in addition to the memorial at Devonport, a large sum has been set apart to augment Government provision for the sustenance of the families of the deceased men, the outstanding liabilities of the expedition have been discharged, a considerable sum

put aside for the publication of the scientific results obtained, and an institute for polar research has been established at Cambridge. The memorial takes the form of a granite pylon surmounted by a symbolic group in bronze with portrait medallions of Capt. Scott and his four comrades below.

We learn from *Science* that Dr. Raymond Pearl has been appointed director of an Institute for Biological Research established by the Rockefeller Foundation, through its Division of Studies, at the Johns Hopkins University, Baltimore. Dr. Pearl will retain a connexion with the department of biometry and vital statistics of the School of Hygiene, as research professor in this subject, and will continue as professor of biology in the Medical School. The whole time of the staff of the new Institute will be devoted to research on general problems of biology, but with especial attention to the biology of life duration and its control, and to the experimental study of the population problem. Dr. Lowell J. Reed has been made professor of biometry and vital statistics and head of the department in the School of Hygiene at Johns Hopkins.

Those interested in cinematography will read with interest, and doubtless with profit, a communication by Dr. K. C. D. Hickman to the Royal Photographic Society on "Colour Vision and the Design of Kiné Theatres," which is published in the July issue of the Society's Journal. He gives no new experimental results, but brings together many physical and physiological facts and discusses their effects on practical results.

At the end of a review entitled "Industrial Research in Cotton" (*NATURE*, August 1, p. 164) it was stated that the volume under notice, the Shirley Institute Memoirs, is not purchasable. We now learn that bound copies of the Memoirs can be obtained, price one guinea, from the secretary of the British Cotton Industry Research Association, Shirley Institute, Didsbury, by non-members of the Association.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: A lecturer in transport in the University of Birmingham—The Secretary (August 20). A lecturer in the department of electrical engineering of the Bradford Technical College—The Principal (August 29). A professor of education at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (September 8). A professor of civil engineering in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (September 14). A lecturer in bacteriology in the University of Birmingham—The Secretary (September 26). A second laboratory assistant in the department of Biochemistry, Oxford—The Department of Biochemistry, University Museum, Oxford. An assistant bacteriologist at the Wellcome Tropical Research Laboratories, Khartoum—The Director, Wellcome Tropical Research Laboratories, c/o The Controller, Sudan Government, London Office, Wellington House, Buckingham Gate, S.W.1. A half-time demonstrator in botany in McGill University, Montreal—The Secretary.

Our Astronomical Column.

PHOTOMETRIC METHODS APPLIED TO VARIABLE STARS—Dr. W. J. S. Lockyer, Director of the Norman Lockyer Observatory, Sidmouth, has recently contributed a very interesting study of the interesting star ϕ Persei ("The Spectrum of ϕ Persei, Type BoPe," *Monthly Notices, R.A.S.*, 85, 580, May 1925). The principal feature of the spectrum is the composite nature of the hydrogen lines and of the ionised lines of several metals, of which iron is the most prominent. For example, H_{β} consists of a broad absorption band on which is superposed a bright emission band of lesser width, on which, again, is superposed a sharp absorption line. The ionised metallic lines, however, do not show the broad absorption band associated with the hydrogen lines. From observations, made more than twenty years ago, on the cyclical positional changes of the absorption lines, the star was recognised as a spectroscopic binary with a period of 126½ days. Lockyer's recent observations refer more particularly to the components of the bright emission bands—of H_{β} , for example. The relative intensities of the two components were measured by the wedge method, employed in the determination of spectroscopic parallaxes. In this way, cyclical changes were detected, and the resultant period found by Lockyer agrees precisely with the period derived from various line-of-sight investigations.

It would appear that this is the first occasion on which the periodicity of a star has been determined by the wedge method. There are indications, in addition, that, superimposed on the 126½ day period, there is a subsidiary period of 21 days; further

observations would appear to be necessary to establish this definitely and more precisely. An interesting suggestion from Lockyer's paper is that ϕ Persei should be a variable star of period 126½ days, and it is hoped, by means of photometric observations, to test this suggestion in the near future.

NEW STAR ATLAS, SHOWING FAINT STARS—Mr. Max Beyer, in conjunction with Prof. K. Graff, of Bergeedorf, is bringing out a very useful set of star maps, including all stars down to magnitude 9.3 and fainter ones if meridian places are available. The first 12 sheets are now ready; they comprise the equatorial zone from $+22^{\circ}$ to -23° ; each sheet covers 2 hours of R.A., the scale being 1 cm. to a degree. The epoch is 1855, but as centennial precession is marked at six points on each map, reduction to other epochs is easy. Nebulae and star clusters are marked with crosses. There is no lettering or nomenclature on the maps themselves, but stars can be quickly identified by their co-ordinates. A slight blemish is the absence of indication of variability. Thus Mira Ceti is shown as an ordinary star of the sixth magnitude (its mean value). These maps should be of great assistance in finding comets and minor planets, or in recognising variables or Novæ. The price of the 12 sheets is only 15 marks—little more than a shilling a sheet—and a reduction of twenty per cent. is made to those purchasing three sets. The whole sky north of Decl. -23° will be completed in 30 charts. The scale is of course less than that of the Bonn maps, but it is sufficient for the identification of objects.

Research Items.

BRUNO'S METAPHYSICS AND GEOMETRY.—"La Doctrine Métaphysique et Géométrique de Bruno," by Dr. Xenia Atanassievitch (Paris: Les Presses Universitaires de France), is not only a fascinating historical study of the great sixteenth-century pioneer of modern science but it is also of first-rate present scientific interest. Dr. Atanassievitch would appear to be a pupil or a colleague of Dr. Petronievics, the professor of philosophy at Belgrade, recently in Great Britain working at the reconstruction of Archaeopteryx, and advocate of a finitistic theory of space, that is, the theory that space is composed of discrete units and is not continuous. Dr. Petronievics holds that only by means of such a theory is it possible to reconcile the paradoxes of Zeno, and we may discover the original form of his argument in this study of Bruno. Like Lucretius, Bruno set forth his philosophical arguments in metrical form, and there can be no doubt that his writings influenced very definitely the mathematical and physical sciences in the seventeenth century. The change which took place in the method of scientific research under the lead of Galileo and Descartes was largely to the credit of mechanical inventions,—the telescope and the microscope,—and it is of extraordinary interest to compare the unaided speculations of Bruno with the new form the theories assumed under the control of experiment. All the distinctions which exercised the philosophers of the seventeenth century—the distinction between the mathematical, the physical, and the metaphysical unit, the geometrical difficulty Descartes encountered in his conception of subtle matter and his rejection of the void, the difficulty for physics which Malebranche discovered in the idea of a minimum sensible, the metaphysical difficulty Leibniz met with in relating God to the monads—are expounded in Bruno, mixed up indeed with much fantastic mythology. In the valuable criticism which follows her able exposition, Dr. Atanassievitch claims for Petronievics that his reconstitution of Bruno's idea is the only satisfactory solution of modern fundamental physical problems.

AN ETHNIC THEORY OF CASTE.—Dr. S. Ghurye makes an important contribution to the discussion of the question of caste in India, in a paper appearing in Vol. 4 of *Man in India*, in which he considers the bearing of the anthropometric data upon this problem. If endogamy is taken as the distinctive feature of caste, arising from a desire of the Aryans to keep themselves free from aboriginal blood, anthropometry should show that the physical type of their representatives in Hindustan proper approximates to what may be assumed to have been the original physical type of the Aryans. This is the long-headed and finenosed type found among the castes of the Punjab and Rajputana regions. These regions, from their geographical position, must have been the site of Aryan settlements. The aboriginal type, on the other hand, may be deduced from the Musahar who, not being within the pale of Hinduism, are like the jungle tribes of Southern India, their chief characteristics being the broad nose and a head which is frequently long but is distinguished from the Aryan head in its absolute measurements. As a result of a comparison of types in the castes, it appears that the Brahman of the United Provinces has essentially the same physical type as the Punjabis and the ancient Aryans. In physical affinity to the Brahman the castes show a gradation corresponding with social status, and there is a similar state of affairs in Bihar. In Bengal and Bombay,

however, there is no correspondence between social gradation and physical differentiation. As one section—the Brahmins—kept itself free from aboriginal blood, while there are intermediate types between it and the representatives of the aborigines, it would appear that the immigrant Aryans of Hindustan tried to impose upon themselves endogamous rules; but only a section carried them out, while others mixed with the aborigines to a greater or less extent.

INSECT FAUNA OF THE BRITISH ISLES.—In the issues of the *Entomologists' Monthly Magazine* for April, May and June there are records of several interesting additions to the fauna of the British Isles. In the April number of that journal, Prof. E. V. Theobald describes seven new species of aphides from various parts of the country. In the same issue, Mr. E. G. R. Waters records three species of small tineid moths, which although known previously from Germany and other countries, had not until recently been detected as British. The species *Brachmia lutatella* H.-S. occurs on the Dorset coast; *Coleophora antennariella* H.-S. was found in beech woods in Oxfordshire, and *Phyllocnistis tremulella* (F.R.) Zell. seems to be more widely spread and has been apparently confused in collections with an allied species. There is also an article by Mr. J. Edwards recording the capsid bug *Miris trispinosus* Rent. as British. In the May and June issues, Mr. G. T. Lyle enumerates several parasitic Hymenoptera of the family Braconidae as new to the British Isles. The June number of the journal also contains a paper by Mr. J. V. Pearman, who brings to notice four species of "book lice" (Psocoptera) which have not previously been known as British, and one of these, *Embiotroctes rectivensis*, is described as new to science. In the same issue, also, Mr. K. J. Morton records a caddis fly (*Mystrophora intermedia* Klap.) not previously known as British—the species being found in the Lake District. It is not a little remarkable that so many additions to our well-worked fauna should have been recorded in such a short period; there are evidently still many species in the more obscure groups awaiting recognition.

THE SWARMING OF ANNELIDS.—L. Fage and R. Legendre continue (*Comptes rendus Acad. Sci. Paris*, t. 180, p. 1373, May 1925) to give results of their experiments in fishing for swimming annelids in the sea by attracting them to strong lights hung in the water. In the present communication, they describe the swarming of the mud-burrowing worm *Scalibregma inflatum* Rathke in the Bay of Concarneau. The worms were sexually mature and swollen with eggs and spermatozoa, the latter being discharged into the water by the bursting of the body wall. The worms gathered round the submerged light and maintained constant and very active revolving and serpentine movements. They were found in October, November and December 1923, but the observations were not sufficiently frequent to determine whether in this case there was any lunar periodicity in the swarming of the sexual shoals, such as the authors had previously shown to exist for certain other annelids.

LOCATING HERRING SHOALS BY AIR-CRAFT.—A series of experiments was undertaken during the month of July 1924, by the Scottish Fishery Board, with the co-operation of the Air Ministry, to ascertain the practicability of locating herring shoals in Scottish waters by means of air-craft. An account of these experiments, prepared by the two observers, Messrs. Henry Wood and George McGee, has now been

published by H.M. Stationery Office (Fishery Board for Scotland, Scientific Investigations, 1925, No. 1. Edinburgh and London: H.M. Stationery Office, 2s. 6d. net.). Three flying boats were used, based on Invergordon, and repeated flights were made over the whole area of the Moray Firth. The weather conditions were on the whole favourable, but only on one evening (July 31) during the course of the experiments was a shoal of herring definitely observed, playing at the surface. Although the experiments were pursued with great diligence and care, and many observations of interest were made, the report shows clearly that the use of air-craft for the purpose of locating fish in these northern waters cannot be considered as a practical commercial proposition.

FLORA OF THE MALAY STATES.—The first local flora for the Federated Malay States is that recently published for Taiping by I. H. Burkill and M. R. Henderson in the *Gardens' Bulletin*, vol. 3, Nos. 9-12, for March 1925. In 1894 C. Curtis published a list of plants and ferns for the Island of Penang, and in 1900 H. N. Ridley published his flora of Singapore, both these appearing in the *Journal of the Straits Branch of the Royal Asiatic Society*; the present authors point out that the fact that Sir Hugh Low was Resident at Taiping from 1877 until 1889, coming there from Borneo, from whence he had already introduced many interesting species into cultivation, has had the natural result that the materials are already available for a relatively complete account of the flora of this area in the Federated Malay States. In the flora, 1980 species of flowering plants are recognised, 41 of these have been introduced, 1939 are natural to the country. The authors contribute a brief account of the habitat and ecology and an analysis of the probable sources of the flora with a very interesting discussion of the 860 species endemic to the Malay peninsula.

ORIGIN OF PETROLEUM.—Strong evidence in support of a micro-biological origin of petroleum emerges from the results of a recent geological survey of a large district occurring to the west of Los Angeles, California. Both Eocene and Miocene shales here abound in the remains of minute organisms which at death sank to the bottom of the sea and formed oozes composed essentially of their own remains. Of these organisms, diatoms with their characteristic siliceous tests are the most conspicuous; calcareous tests of foraminifers, together with a few siliceous radiolarian skeletons, have also been identified. The oozes thus formed are, according to Mr. W. S. W. Kew (*Bulletin* 753, United States Geological Survey), probably comparable to the diatom, globigerina and radiolarian oozes now in process of formation in the ocean, though not necessarily in deep water. The process of formation of petroleum from the organic matter from within the siliceous and calcareous tests is bound up with chemical change influenced by geological conditions of pressure and moderate heat. An indirect proof of such an origin of oil in this region is furnished by the fact that commercial quantities are recoverable from sandy reservoirs which overlie or are associated closely with these diatomaceous shales, and in the case of the Sespe formation (Eocene-Oligocene) oil is never found unless the Eocene shales are present beneath it. In view of the enormous quantities of petroleum recently produced from the Los Angeles region, it is noteworthy that the author is of the opinion that a first essential to the accumulation of oil "over all of California" is that the mother-rock of the oil is present; in other words, that oil has not migrated from great stratigraphical or geographical distances. In most cases in this region,

the mother-rock is involved in the very structures from which petroleum is ultimately obtained.

SIZES OF CRYSTAL UNITS.—Recent redeterminations of the sizes of the crystal units of caesium triiodide and dibromo-iodide by R. M. Bozorth and L. Pauling, recorded in the *Journal of the American Chemical Society* for June, are not in agreement with the values determined by Clarke and Duane (1923). The latter authors used a new method of crystal analysis which they had devised; since Bozorth and Pauling adopted the spectrum and Laue photographic method, the above discrepancy in results is of some importance.

THE ACTION OF RADIATION ON GASEOUS MIXTURES.—It has been shown by Franck and Cario that, when hydrogen containing mercury vapour is illuminated with light from a mercury arc lamp so as to excite the mercury atoms, the hydrogen becomes dissociated by a secondary reaction due to collisions of the second kind. In the *Zeitschrift für Physik* of June 30, Dr. H. Szentleben describes an investigation in which this fact is made use of to study the change in heat conductivity of hydrogen when dissociated. A mixture of dry hydrogen and mercury vapour is introduced into a glass tube with a quartz window, or into a quartz tube, through which passes a wire heated by an electric current to about 100° C. above room temperature. The resistance of the wire is measured while the heating current flows, and the tube is illuminated with a mercury arc lamp. Owing to the increase in heat conductivity of the illuminated hydrogen, the temperature of the wire fell, as indicated by a drop in its resistance. The results are of a preliminary nature, but show that the observed effect is really due to alteration in the thermal conductivity of the hydrogen, due to dissociation produced by the incident light. Theory shows that the coefficient of thermal conductivity depends on the number of degrees of freedom of the gas molecule, the mean molecular velocity and the molecular diameter. All these are altered when dissociation takes place, and the effect of alteration of the last quantity is the most important, since conductivity varies inversely as the square of the molecular diameter, so that dissociation results in an increase in conductivity.

HIGH FREQUENCY INDUCTIVE ELECTRIC FURNACE.—M. G. Ribaud describes in the *Comptes rendus* of the Paris Academy of Sciences for June 8, an electric furnace with which temperatures above 3000° C. can be obtained, which can easily be opened when hot and can be used repeatedly without renewal of parts. It consists of a cylinder of graphite, which is heated inductively by means of a high-frequency current, and a cylinder of porous carbon made of large grains, only slightly compacted, and forming a very poor conductor both for heat and electricity. This cylinder forms a continuation of the graphite one, and is closed by a plug of the same porous carbon with a central piece, closed by a glass plate, through which a current of inert gas circulates to remove all fumes and facilitate photometric pyrometry. If the portion of the furnace composed of porous carbon is long enough, at least 8 cm., it is possible to remove it by hand, even when the interior of the furnace is at a temperature of 3000° C. Temperatures higher than this have been obtained using 10 kilowatts, with a volume of 100 c.c., 2500° with 500 c.c., and 1800° with 3000 c.c. As compared with this, a resistance furnace formed of rings of graphite piled one on another, studied at the National Physical Laboratory by Rosenhain and Pryor, gave 1700° C. in a volume of about 500 c.c., with 10 kilowatts.

The Third International Congress of Entomology.

THE third International Congress of Entomology, held at Zurich on July 19-26, was attended by about 200 representative entomologists and about 50 guests including 40 ladies. The Congress proved a great success. More nations were represented than at Brussels or Oxford, and it was a matter of regret that France, Italy and Belgium were not officially represented. One is glad to add, however, that the rate of exchange unfavourable to these countries was a contributory cause to the absence of men who will be welcomed at the next conference three years hence. During the Congress, members had opportunity of examining the fine collections in the adjoining Entomological Institute and the University Zoological Museum, as also the collection of Prof. Standfuss and the palaearctic collection of Dr. Corti. The Concilium Bibliographicum also received its quota of admiring visitors.

The town of Zurich itself, in the fine weather of the week, with its famed Lake, received the usual meed of praise, and especially it showed to great advantage as it was viewed during the ascent of the Uetliberg by funicular railway on one of the Congress excursions; while in the descent in the dark, the lights of the numerous buildings dotted all over the hillside suggested so many majestic glow-worms.

The Congress was opened by Dr. A. von Schulthess, its popular president, who took occasion to emphasise the successes of the early Swiss entomologists. He was followed by the Rector of the University, Prof. Dr. Bleuler, who gave the delegates a cordial welcome on behalf of the Canton of Zurich and of the University. Dr. Bleuler, besides emphasising the great importance of insects in the spread of various diseases, referred to the psychic problems underlying insect life and habits, a branch of the subject to which Swiss entomologists have made valuable contributions.

The forenoons were devoted to general meetings, the afternoons to sectional ones. It is impossible to name all the papers presented as this summary can only be a general one. As regards the forenoon meetings, Dr. F. Ris (Switzerland) read an interesting paper on the geographical distribution of insects in Switzerland, dealing first of all with the effects of glacial times, when Switzerland was covered with ice, and going on to quote examples of the influence of man on the relationship between animals and plants. Prof. Leiper, of the London School of Tropical Medicine, spoke on "Some Outstanding Questions in Medical Entomology." He quoted instances of the already proved relationship between diseases due to protozoa and worms conveyed by insects or arachnids, and named numerous other important diseases in which a "vector" insect or arachnid host might be justly suspected. More accurate knowledge regarding these is greatly desired, and a strong plea was made for the co-operation of the parasitologist and the economic entomologist.

The fascinating subject of mimicry never fails to attract a large audience. As regards the explanation of specific instances—teleological, physiological, chemical, mechanical, and so on—one can only say "*Tot homines quot sententia*." On the present occasion, Prof. E. B. Poulton, of Oxford, who has done so much for the success of the three International Congresses, and Prof. van Bemmelen, of Holland, were the protagonists. The debate between these two experts was a model of how such a controversy should be conducted. Their mode of presentation of the subject, and their manner of differing, won the listener, who was tempted to throw logic to the winds and wish or even declare that the debaters were both right,

as of course up to a point both were. Prof. Poulton illustrated, by means of coloured figures and actual specimens, mimicry in African butterflies of the nymphaline genus *Charaxes*, and pointed out new aspects of the subject. The genus *Charaxes* is one of powerful fliers and yet there is much mimetic association. They often mimic each other in pattern, as is most evident in the females of the smaller species, which resemble the males as well as the females of larger species. Dr. Richard van Someren has proved by breeding from known female parents that three of these mimics in Uganda, although totally different in appearance, are the females of the same species. Mr. C. F. M. Swynnerton has shown that the quality mimicked in this case is the quality of "fighting weight" and toughness, rendering the butterflies, and especially the larger species, very difficult to hold and reduce to a condition in which they can be comfortably swallowed. Prof. van Bemmelen argued that different mimetic patterns are derived from a common ancestral pattern and need not imply any mimetic association.

At another meeting mimicry was brought up again by the veteran Father Wasmann, in his address on the staphylinids which live in happy association with certain ants. This was only one of several weighty pronouncements from Father Wasmann, as, for example, his contribution to the discussion on Dr. H. Eidmann's paper on "The Foundation of Colonies in Ants." Setting aside the foundation of a new colony by secession, there are two principal types of sexual reproduction of an ant colony. One is the independent or autonomic colony foundation where the fertilised female is able to found a colony by herself and without any aid. In the other case the female requires, for rearing her young larvæ, the help of other ants. One type of these is the red slave-working ant *Formica sanguinea*, which lives in mixed colonies with workers of *Formica fusca*. Eidmann isolated a fertilised queen of *F. sanguinea* and after a fortnight put her into an artificial nest consisting of some twenty workers and one hundred cocoons of *F. fusca*. The introduced queen attacked the workers, killed one after the other in severe fight, and took possession of the cocoons. She looked after the cocoons and in a short time had a little troop of newly issued slave ants to help her to rear her eggs and larvæ.

Mr. F. Balfour Browne, of Cambridge, spoke on "The Evolution of Social Life among Caterpillars," basing his argument on a number of illustrated cases chosen from the Lepidoptera, beginning with the silk-spinning habit as protective and going on to feeding nest or web, and then to home nests. C. B. Williams, of Egypt, spoke on "Some Unsolved Problems of Butterfly Migration," quoting interesting examples and inviting co-operation and exact observation.

Instructive papers on the history and progress of the study of entomology in different countries, in its various branches, were given by Escherich for Germany, Tragardh for Sweden, Mokozecki for Poland, Fletcher for India, and Urich for the West Indies.

As regards the sectional meetings, many valuable papers were read, and it may safely be hazarded that the volume of the Proceedings of the Congress will be found very helpful to entomological workers all over the world. It is impossible in this summary to mention all the individual papers. The sections were: (1) Morphology, Anatomy and Physiology; (2) Systematic and Geographical Distribution; (3) Nomenclature and Bibliography; (4) Biology and Development; (5) Applied Entomology; and it must

suffice to say that there was no lack of material or of discussion. As the various sections met at the same hour, it was not easy always to decide which paper to miss, so that with a choice of good things one often wished, like Boyle Roche's bird, to be in two places at the same time. Of such papers as I managed to hear myself, I may mention Horn of Berlin on systematic entomology, Edwards on the phylogeny of nematocerosous Diptera, the Aphid papers of Börner, Davidson and Munro, Pictet on parthenogenesis, Prell on Polyeder diseases of insects, Brun on the anatomy of the brain, and Jablonowski's papers in the Economic Section. To listen to Jablonowski "annihilating time and tearing a passion to tatters" was one of the treats of the Congress. The wide appeal of the Congress will be gauged if in addition to the names already given I mention Handlirsch of Vienna, whom one was glad to see taking an active part again, Nuttall and Scott of Cambridge, Ettringham of Oxford, Carlier of Birmingham, Heymons, Schwartz and Schuberg of Berlin, Eckstein of Eberswalde, Reh of Hamburg, Everts of Holland, Johannsen of the United States, Lord Rothschild and Jordan of Tring (the Congress owed much to Jordan's organisation and committee work), Marshall and Neave of the Imperial Bureau of Entomology, Waterston and a worthy representation from the British Museum, Blendowski of Poland, Rennie from Scotland, Turati from Italy, Kryger from Denmark, and Monzen of Japan, and a naturally large representation of well-known Swiss entomologists. A special tribute must be paid to Dr. L. O. Howard, of the United States Department of Entomology. Always in a position to help and using his position to help, Dr. Howard has earned the gratitude of entomologists everywhere. Capable and kindly, always with the right word, and with tact as his middle name, Howard gives one the feeling that were there a dozen representative ambassadors like him in the political world, we would soon have, what some of us long for, the United States of Europe, each nation no longer at enmity with the other but working out its own salvation following the lines of its own culture and psychology. Certainly there was a spirit of friendliness and goodwill at the Congress, attesting that science has no limited boundaries but is international.

Much hard committee work was done during the week, and the Section on Entomological Nomenclature has so co-ordinated opinions from various sources that hopes are high for general agreement.

The nomenclature question is in some ways an appalling one to tackle, and it is surprising the amount of time and labour expended in trying to reach an international system that would be clear and consistent.

The position of systematic entomology and the status of the systematist in university and museum were also subjects of committee work, and the Congress passed resolutions that are satisfying. In the economic sections also, attention has been focussed on the need for a recognition of the deeper problems underlying entomological research, and the Congress passed the following resolution: "The Congress considers it essential that the problems underlying Applied Entomology should be studied, and desires to impress upon Governments and Institutions concerned with investigations in Applied Entomology that time must be devoted to Systematic Entomology and fundamental research, such as Insect Physiology, Ecology and Pathology, since only by the study of these can insect control be placed on a sound basis."

This report is already long else one would have liked to mention some of the more humorous features of the week's meeting. Only one can be mentioned. A steamer heavily laden with the members of the Congress, in a sail round Lake Zurich, reached a certain little town at dinner-time. "The Assyrians came down like a wolf on the fold," or, entomologically, the locusts swarmed ashore to find that the village Chief of the Commissariat had blundered and food failed. But this was a meeting of biologists, and soon was seen in practice Natural Selection working through the struggle for existence and the survival of the fittest—the badge of the fit taking the guise of half a sausage. Whether the raiding habits developed in the struggle will become an acquired character time alone can show. One is glad to add, however, that as opposed to "Nature red in tooth and claw" the co-operative and ethical aspect of the struggle for existence received due illustration.

On the evening preceding the close of the Congress a banquet was held and every one enjoyed the night's social leisure. On the last day of the Congress two papers were read and the Congress then resolved itself into a Business Meeting. The president was heartily congratulated on a highly successful meeting.

Several extra excursions were arranged to follow the close of the Congress, e.g. to the Rigi Summit and the Jung Frau. R. STEWART MACDOUGALL.

Lathyrism.

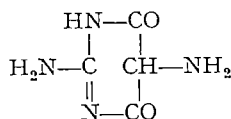
OF the chronic diseases which are directly related to the food supply and only indirectly connected with the presence of infective agents, most attention has in recent years been paid to that group in which the symptoms are due to the deficiency of some element in the diet, more especially that of one of the vitamins; scurvy, beri-beri, and probably rickets are among the diseases in this class. The other group, of which ergotism is the best known example, is due to the presence in the food consumed of small quantities of some poison, which after prolonged administration affects various organs of the body with the production of symptoms. The chronicity of the disease distinguishes this group from cases of acute poisoning due to bacterial products taken with the food or to the ingestion of some well-known poisonous substance.

The occurrence of lathyrism, which has been met with in India and in countries bordering on the Mediterranean, has been for long ascribed to the consumption of the seeds of pulses of the genus *Lathyrus*. In India the seeds of *Lathyrus sativus*, known in the vernacular as *khesari*, occupy a large

place in the diet in certain districts, in which also a form of paralysis is frequently seen, especially among those who utilise the pulse as the staple article of their diet. L. A. P. Anderson, A. Howard, and J. L. Simonsen (*Indian Journ. Med. Research*, 1925, vol. 12, p. 613) have recently conducted an investigation into this disease, from the results of which certain important conclusions can be drawn. At the outset of their work, the investigators recognised that the crop of *Lathyrus sativus* is scarcely ever grown in pure culture, but is frequently contaminated with various weeds; the seeds of one of these, the vetch *Vicia sativa*, L. var. *angustifolia*, were present in every sample of *khesari* obtained from districts in which lathyrism is common; attention was thus attracted especially to this weed, which is known in the vernacular as *akta*. As the result of both chemical analysis and feeding experiments with ducks and monkeys, the important conclusion was reached that pure *khesari* seeds contain no alkaloids; in fact they form a nourishing diet for these animals.

Quite different results were obtained with the seeds

of the vetch *akta*. Chemical analysis has confirmed the results of previous investigators, at least two glucosides are present, one vicianin, closely related to amygdalin, the other, vicine, yielding on hydrolysis δ -glucose and the base divicine. The latter is an oxy-amino derivative of pyrimidine with the formula



Animal experiments have shown that divicine sulphate or hydrochloride is definitely toxic; doses of 0.6 mgm. per gm. body weight injected subcutaneously into young guinea-pigs produced convulsions lasting for about an hour, followed by paralysis and death in a few hours; post-mortem examination disclosed congestion of many of the organs, especially the central nervous system, and a peculiar rose-pink staining of the medulla of all the bones, this colour is the same as that assumed by solutions of divicine hydrochloride on exposure to the air, and its occurrence is considered by the authors to be evidence that the base is actually absorbed after injection. Injections of vicine or vicianin in similar amounts produced no ill effects which could be attributed to the substance injected; the experiments do not exclude the possibility that larger doses may be harmful or that if vicine is taken

with the food it may be hydrolysed into glucose and divicine during digestion.

The feeding experiments with ducks and monkeys also appear to be almost conclusive. In the case of the former, only birds on a diet containing *akta* have shown any symptoms, and the majority of those on these diets have been affected. The syndrome is characteristic, the symptoms being referable to an affection of the nervous system and including ataxia and paresis; early death is the rule. The incidence of symptoms in the case of monkeys on diets containing *akta* has not been quite so general, and the symptoms themselves have usually been less well defined, but in every case they can be referred to a lesion of the nervous system, no characteristic symptoms have been shown by any animal on *khesari* unless *akta* was also present in the food. In neither case are the symptoms those of typical lathyrism in man, although some of those occurring in the monkeys have been observed in human beings. But so frequently do the effects of similar agents differ in animals and man, that the difference observed here seems to be no objection to the application of the authors' results directly to the latter. Thus the important conclusion is reached that lathyrism is due to the consumption of the seeds of the vetch *Vicia sativa*, a weed which frequently contaminates the crop of the pulse *Lathyrus sativus*. Hence it should be possible to exterminate the disease by ensuring that the crop is grown pure.

The Museums Association.

ANNUAL CONFERENCE.

THE thirty-sixth annual conference of the Museums Association was held at Exeter on July 6-11, when more than 120 delegates attended. A civic welcome was extended to the delegates by the Mayor of Exeter. The president of the Association for the year 1924-25 was Mr F. R. Rowley, the Royal Albert Memorial Museum, Exeter. The president in his address¹ gave a brief résumé of the museum movement in Exeter, and traced the development of the Museum from its small beginnings more than a century ago. He then discussed the question of a Royal Commission on museums. In pressing the claims of the provinces to a wider measure of support, he said they are actuated by no spirit of antagonism to the claims for increased expenditure which is being advanced by museums in the metropolis. Following on this he dealt with the wasteful destruction of wild life which threatens the very existence of some of our indigenous plants and animals.

Mr. Robert T. Jackson, of Peterborough, U.S.A., read a paper on "Ink and Paper for Museum Labels," giving his experiences over a long period on this subject. Major Stanley S. Flower contributed a paper and opened a discussion on "The Scientific Value of Small Aquaria." He emphasised the value of keeping data with regard to the animals kept in small aquaria, as much information about the longevity of these animals might thereby be obtained.

A paper on "Botanical Modelling for Museum Purposes" was read by Mr W. E. Mayes, Leicester. He described in detail the process of modelling various specimens and showed examples of his own work in this connexion. Dr. F. A. Bather discoursed on "A Cargo of Notions from America," and described in detail the system adopted in American museums to aid visitors in their survey of the various departments. He emphasised the fact that the museums in the United States are far ahead of those in England

in the use of electric light for the lighting of museum cases. Mr. W. Stanley Lewis, head of the Department of Geography in the University College of Exeter, read a paper on "The Place of Museums in the Teaching of Geography." He suggested that good might result from a conference between such bodies as the Museums Association and the Geographical Association. The last paper was by Mr. E. Rimbault Dibdin, who discussed "The Proper Function of a National Gallery." He remarked that the authorities of the National Gallery complain of lack of space, but he considered that it would be better if the Gallery was given up wholly to foreign art and all British pictures were transferred to the British Gallery at Millbank.

Several trade exhibits were displayed during the Conference as well as exhibits by individual members. Of exceptional interest was a special exhibit of Old Exeter and Devonian Silver of the sixteenth, seventeenth and eighteenth centuries. The social side of the conference was not neglected. On Tuesday evening the Mayor gave a reception to the delegates at the Royal Albert Memorial, while the local committee entertained the delegates to lunch. The local programme included a visit to the Exeter Historical Museum and the Cathedral, where a short organ recital was given by Dr. E. Bullock. The party was afterwards conducted over the Cathedral. The delegates also paid visits to places of interest in the city. Miss M. Tothill, the curator, addressed the party on the St. Nicholas Priory, and an inspection was made of the Hall of the Weavers, Fullers and Shearmen, the Hall of the Vicars Choral and Bampfylde House. An address on the city monuments and regalia was delivered by the Town Clerk (Mr. H. Lloyd Parry) in the Guild Hall. An excursion took place to Bradfield, the home of the Waldron family, by invitation of Commander and the Hon. Mrs. Adams, while the Sheriff of Exeter entertained all the delegates at a garden party in the Rougement Gardens.

¹ The presidential address and the papers and discussions will be published in the *Museums Journal*, commencing August 1925.

University and Educational Intelligence

CAMBRIDGE—Mr. J. A. Carroll, Sidney Sussex College, has been appointed University lecturer in astrophysics. Mr. G. U. Yule, St. John's College, has been reappointed University lecturer in statistics. Dr. A. H. Evans, Clare College, has been appointed a member of the Council of the National Trust for Places of Historic Interest or Natural Beauty. A. Lourie, St. John's College, has been nominated to the Choate Memorial Fellowship at Harvard University. W. A. H. Rushton, Emmanuel College, has been elected to the Michael Foster Research Studentship in Physiology. C. S. Deakin, Queen's College, and W. B. C. Perrycoste, Sidney Sussex College, have been awarded the John Winbolt Prize for a joint dissertation on the "Theory of Transverse Oscillations of Girders."

The Botanic Garden Syndicate reports the addition of 85 specimens of rare species of the genus *Rosa*, presented by Mr. C. C. Hurst, also a valuable collection of species of *Iris*, mostly collected wild, from the executors of the late Hon. C. N. Rothschild. An alpine house has been presented to the Garden by Mr. J. Cherrington.

On the occasion of the meeting of the International Astronomical Union at Cambridge, the honorary degree of Sc.D. was conferred upon President Campbell, M. Baillaud, Prof. de Sitter, Prof. Nagaoka, and Prof. Schlesinger.

The joint coal-mining diploma of the Universities of Cambridge and Birmingham has been approved by the Board of Trade.

DR. G. M. SHRUM, who has been associated with the low temperature laboratory at the University of Toronto since its inception, has been appointed assistant professor in physics at the University of British Columbia, Vancouver, B.C.

THE following awards for the year 1925-26 have been made by the Salters' Institute of Industrial Chemistry and approved by the Court of the Company—1924-25 fellowships have been renewed to Mr. H. H. Evers, University of Liverpool, Mr. K. Knight Law, University College, Nottingham; Mr. H. S. Pink, University College, Nottingham, and University of Oxford, and Mr. V. E. Yarsley, the University of Birmingham. Fellowships have been awarded to Dr. R. Campbell, Armstrong College, Newcastle-upon-Tyne, and University of Oxford, and Mr. R. O. Gibson, University College, London. The Salters' Institute has also awarded 70 grants in aid to young men employed in chemical works in or near London to facilitate their further studies.

AT Budapest an English College is to be established under the auspices of the Ministry for Religion and Public Instruction. Each year twelve students of the College will proceed to Great Britain for further study in one or other of the Universities of Oxford, London, and Aberdeen. Three years ago, Hungary's economic situation was so desperate that an inter-university committee was formed to save scientific workers from having to abandon their work owing to lack of equipment and means of subsistence. In a report by Prof. Emile de Grösz on the three years' activities of this committee, it is stated that the Rockefeller Foundation has made grants for travelling scholarships and sends 70 periodicals in the English language, while a German society sends 261 German publications for the use of the universities, and the American Science Extension Committee proposes to arrange exchanges of American and Hungarian scientific workers.

Societies and Academies.

COPENHAGEN

Royal Danish Academy of Science and Letters, October 17.—C. Wesenberg-Lund. Contributions to the anatomy and biology of the genus *Zoothamnium*. During two years' study of *Z. geniculatum*, special attention has been paid to the so-called macrogonidia, their origin and significance for the formation of new colonies.

December 12.—N. E. Nørlund. A table of the Riemann zeta function.—Harald Bohr. New proof of a general theorem of Kronecker on diophantine approximation.

January 9.—N. Bjerrum and L. Ebert. On some recent investigations concerning transference numbers and amalgam equilibria in mixtures of strong electrolytes. Some new experimental investigations, which have been regarded as incompatible with the hypothesis of complete ionisation of strong electrolytes, are discussed and explained from the view-point of this hypothesis.

January 23.—C. G. Joh. Petersen. How do whales swim? Whales swim by moving the caudal fin up and down; this is accomplished by means of the tail with its strong muscles, whereas the proper muscles of the caudal fin give this fin the rigidity suitable to the speed. When the speed is high, only small movements are made, for which reason the animal then only appears to quiver, the movements, therefore, are difficult to observe.

February 6.—Th. Mortensen. Antarctic zoogeographical studies. The study of the marine fauna, especially the echinoderms, supports the theory of a previous land connexion between Antarctica and South America (the Magellanic region). The Kerguelen group must also have been directly connected with that region. On the other hand, the so-called "subantarctic" islands, New Zealand, the Auckland-Campbell Islands, do not, as regards their echinoderm fauna, belong to the subantarctic region, but form a part of the New Zealand region. The correspondences between the Australian and the New Zealand echinoderm faunas would seem to be more naturally explained through Wegener's continental drift theory.

February 20.—N. Bohr. On the law of conservation of energy. The attempts to develop an atomistic interpretation of directly observable phenomena have led us to recognise the necessity of revising the ideas hitherto underlying the description of natural phenomena. Our present conceptions would not seem to allow of a detailed description of atomic processes which presumes the law of conservation of energy, which occupies a central position in the classical description of Nature.—C. Tate Regan. Dwarfed males parasitic on the females in oceanic angler-fishes (*Pediculati Ceratolidae*). (Proc. Roy. Soc. London, B, vol. 97, 1925.)

SYDNEY

Royal Society of New South Wales, June 3.—A. R. Penfold. The essential oil of *Boronia citriodora* and the occurrence of citronellol. *B. citriodora* belongs to the snow regions where it thrives, being especially abundant around Cradle Mountain, Moina, Tasmania. The leaves and terminal branchlets yielded from 0.75 per cent. to 0.93 per cent. of a sweet odiferous oil containing citronellol (80 per cent.), citronellol esters (principally acetate with some valenianate, d-a-pinene, sesquiterpene, a paraffin (m.p. 64-65°C.), etc.

WASHINGTON.

National Academy of Sciences (Proc. vol. 11, No. 6, June).—O. E. Glenn: A note on the abundance of differential combinants in a fundamental system.—C. N. Moore: On the application of Borel's method to the summation of Fourier's series. Borel's method is not so effective as Cesàro's in summing Fourier's series but is more effective than ordinary convergence.—S. Lefschetz: (1) Intersections of complexes on manifolds. (2) Continuous transformations of manifolds.—H. S. Vandiver: Laws of reciprocity and the first case of Fermat's last theorem.—E. W. Berry: A species of *Musa* in the Tertiary of South America. Fossil seeds of a species of *Musa* have been found in the coal measures of the Cerros de Guadalupe and Montserrat, Colombia, in a horizon probably oligocene. The discovery supports the statements of old writers that the banana was a staple food in America in pre-Spanish times.—P. Sushkin: Outlines of the history of the recent fauna of palæarctic Asia. The fauna is divided into two groups characteristic respectively of the northern zone and the southern or High Asian zone. In the northern zone, the indications are that the Pliocene climate was humid and mild, later there was local glaciation followed by a dry, continental period with steppe invaded by woodland. High Asia is characterised by desert, mountain and dry highland types; they are of ancient origin, but their present dominance is recent. Types with broken distribution are characteristic of more fertile conditions. There was no large inland basin in High Asia, during the Tertiary.—A. H. Compton. On the mechanism of X-rays scattering. Bennett, using two point counters, one to receive the recoil electron and the other the scattered quantum, finds many simultaneous impulses, in accordance with quantum theory predictions. Simon and Compton, using stereoscopic cloud expansion photographs showing a recoil electron and a secondary β ray track produced by the scattered X-ray quantum, find that the tracks in the majority of photographs are in accordance with the quantum theory prediction. The evidence is thus against any spreading wave theory of radiation, which requires that there should be no correlation between the direction of the recoil electron and that of the effect of the scattered quantum.—D. C. Miller. Ether-drift experiments at Mount Wilson (see NATURE, July 11, p. 49).—H. N. Russell: The intensities of lines in multiplets. I. Theory; II. Observed data (see NATURE, May 30, p. 835).—R. A. Millikan and I. S. Bowen: New light on two-electron jumps. Whenever a given type of spectral line progresses linearly with atomic number (irregular doublet law), the electron jumps originating it take place between orbits of the same total quantum number. Hot-spark electrometry shows that series of two-valence atoms are characterised by five nearly equally spaced bars; three-valence atoms show four bars. These characteristics are due to the simultaneous jumping of two electrons. The movement of one electron disturbs the system, causing a fellow-electron to make a similar jump.—H. M. Evans and G. O. Burr: The anti-sterility vitamin fat soluble E. Rats fed on synthetic food mixtures of fat, carbohydrate and protein with an appropriate salt mixture and vitamins A and B grow well, but sooner or later develop complete sterility. In the male there is complete destruction of germ cells, but in the female ovulation continues though gestation is interrupted by the death and resorption of the developing. This condition can be remedied by feeding with certain single natural foods containing the new food factor, vitamin E. Vitamin E is fat soluble and remarkably stable

to heat, light and chemical change; it is present in many animal tissues, abundant in leaves and seeds and especially in the wheat embryo. Cod-liver oil is notably lacking in vitamin E.—Grace MacLeod, Elizabeth E. Crofts and F. G. Benedict: The racial factor in metabolism. Measurements on seven Chinese and two Japanese women in American colleges showed that the average metabolism of these orientals was about 10.4 per cent. less than that taken for American women. Even granting the latter should be decreased by 5 per cent., there seems to be a specifically lower metabolic rate for Chinese and Japanese women.—C. Voegtlin, J. M. Johnson and Helen A. Dyer. Protoplasmic action of copper and gold. In view of the relative mass of protoplasm and of salts of these heavy metals, and of the relatively large surface exposed, it is considered that even in very diluted solutions (1 in 10^7), sufficient metal ions are present to exert a toxic effect by chemical means. Glutathione and cysteine have a protective effect, suggesting that the normal toxicity is due to "asphyxia" from loss of the glutathione normally present in small quantities in tissues.—G. H. Parker: Activities of colonial animals. III. The interrelation of zooids in soft corals. A mechanical stimulus or light induces only local response in gorgonians: the zooids of *Renilla* are all affected by a local stimulus, suggesting an interconnecting nerve-net.—Lucy G. Taliaferro. Periodicity of reproduction, infection and resistance in bird malaria. Periodicity of occurrence of high values of mean size of parasites is unaffected throughout the infection, indicating that the rate of reproduction remains constant. Some destruction of merozoites always occurs, and this natural resistance factor increases in potency at the crisis and is maintained through the latent period.—Emma L. Fisk: The chromosomes of *Zea Mays*. A haploid number of 10 chromosomes and a corresponding diploid number of 20 have been found, except in Black Mexican sweet corn, which generally has 22 chromosomes.—F. G. Pease: Measurement of the spectroscopic binary star Mizar with the interferometer. The determinations are in good accord with the results from spectroscopic data.—F. H. Seares and P. J. van Rhijn. Distribution of the stars with respect to brightness and distance from the Milky Way (see NATURE, June 20, p. 948).—G. Stromberg: The general distribution of cosmic velocities. Group motion varies from 12 km. per sec. for the Cepheids of long period to about 300 km. per sec. for stars of maximum velocity dispersion, globular clusters and spiral nebulae; thus the solar motion is dependent on the class of object to which its motion is referred.

VIENNA.

Academy of Sciences, May 14.—F. Kerner-Marilaun: The influence of the variable elements of the earth's orbit on the form of the European temperature chart during the Tertiary epoch. By means of Spitaler's calculations for the temperatures of extreme land and sea climates, and by means of the author's own method of geographical temperature analysis, it is possible to fix limits to the range within which the distribution of temperature oscillated in Tertiary Europe. The influence of the astronomically determined temperature change on the plant world of the Tertiary is indicated, and the floral migrations of deciduous and evergreen plants.—G. Sachs: On decomposition of azimenthines by mercury. The actions on benzaethylamin, on benzalbenzylamin, and on benzalanilin of mercury chloride and of mercury acetate.—H. Handel-Mazzetti: New Chinese plants (xxxiv). Includes five sorts of *Quercus* and three of *Vaccinium*.

June 12.—K Przibram On coloration and luminescence by Becquerel rays —H Benndorf Outlines of a theory of the earth's electric field (I) —F Knoll. On pan-algebraic manifolds —W Olbrich New problems in projection —G Weissenberger, F Schuster and J. Lielacher. On organic molecular compounds (xiv.) Chlorophenol and bromoform —M. Kohn and G Soltesz On a new tri-bromo-phenol, the 1-oxy-3,4,5-tri-bromo-benzol, and a new tri-bromo-cresol, the 1-methyl-2-oxy-4,5,6-tri-bromo-benzol (Sixteenth communication on bromo-phenols) —M Kohn and L Schwarz Preparation of brominated α -naphthochinon (Seventeenth communication on bromo-phenols) —R. Dworzak Preparation of di-bromacet-aldehyd-acetal by direct bromination of paraldehyde. —J. Schorn Macroscopic study of the earthquake of March 26, 1924, and of its after-shocks —A. Schedler Microseismic study of the earthquake of March 26, 1924 —F. M. Exner On the interaction of water and gravel in rivers Theoretical, experimental and photographic work on the sandbanks of the River Mur, south of Graz. —H Handel-Mazzetti New Chinese plants New species of Hydrangea and Senecio —A Tauber On the integration of linear differential equations (Fifth contribution.)

June 18.—G. Weissenberger, F Schuster and J. Lielacher On organic molecular compounds (xv) Aromatic amines

June 25 —M Chiba On the tongue-jaw reflex of the same side and crossed sides —H Neudorfer. Construction of the principal tangent curves on net-surfaces —H Jacob Influence of various stimuli on the growth of morphologically dissimilar parts of plants Weak solutions of potassium chloride and other salts were used and experiments made with Impatiens, Syringa and Phaseolus Resting plant organs were made to grow. Similar salts influence the growth of pollen-tubes —L Mirskaja: Changes in plants produced by removing the blossoms. —A Smekal. On the influence of the pores of solid bodies on molecular mobility and rigidity. Crystals are generally considered to have a solidity which they do not really possess; the lattice structure is liable to microscopic or submicroscopic interruptions and the rigidity of the apparent crystal is much less than the real molecular rigidity Self-diffusion in solid salts may be an internal surface process. —G Klein and J. Kisser The assimilation of nitrates by higher plants. An inquiry into the stages between nitrate and amino-acid. On feeding Phaseolus and Zea with $-\text{NO}_2$ in sterile culture solutions, $-\text{NO}_2$ and NH_4 — appeared in the culture medium, and NH_4 — also within the plant —F Trauth Geology of the northern Radstatter-Tauern and their foot-hills

July 2 —M Kohn and L Schwarz On the chinoid product of oxidation of benzal-di- β -naphthol. —E Emich Further remarks on the rubidium- (caesium-) silver-gold-halogen salts. —J. Vogel: Investigations on rubidium- (caesium-) silver-gold-halogen salts. —E. Reichl Contributions to the knowledge of the isomorphic relations of the cupro- and silver halogen salts

Official Publications Received.

Berichte der Naturforschenden Gesellschaft zu Freiburg i. Br. Herausgegeben von Prof Dr J. L. Wilder Vierundzwanzigster Band. Erstes Heft. Pp 123+92+46+33. Zweites Heft. Pp 28+16+8+20 (Freiburg i. Br. Speyer and Kaerner)

Marconi's Wireless Telegraph Co Ltd Report of the Directors and Statement of Accounts for the year ended 31st December 1924; to be Presented at the Annual General Meeting of the Company, to be held at the Hotel Victoria, Northumberland Avenue, London, W C 2, on Friday, the 31st July 1925, at 12 o'clock noon Pp 8 (London Marconi House)

University of Cambridge: Solar Physics Observatory Twelfth Annual Report of the Director of the Solar Physics Observatory to the Solar Physics Committee, 1924 April 1-1925 March 31. Pp 7. (Cambridge)

The North of Scotland College of Agriculture (Guide to Experiments and Demonstration Plots, at Craigstone, 1925 Pp. viii+80 (Aberdeen)

University of Bristol Prospectus of the Faculty of Engineering which is Provided and Maintained by the Society of Merchant Venturers in the Merchant Venturers' Technical College Seventeenth Session of the Faculty and Seventeenth Session of the College, 1925-26 Pp 32 (Bristol)

City and Guilds of London Institute. Report of the Council to the Members of the Institute, 1925. Pp lvi+105 (London Gresham College)

Ministerio da Agricultura, Industria e Commercio Directoria de Meteorologia Causas Provaveis das Secas do Nordeste Brasileiro. (Conferencia realizada no Club de Engenharia no dia 30 de Dezembro de 1924) Pelo Dr. J. de Sampaio Ferraz Pp 40 (Rio de Janeiro)

Union of South Africa Department of Agriculture Division of Chemistry Series No 58, Science Bulletin No 86 Some Experiments on the Solubility of Sulfanilic and Grahamstown Phosphates in the Soil By A Stead Pp 15 3d Division of Chemistry Series No 55, Science Bulletin No 87 Comparative Results of Analyses of Spirits and Brandy (Read before the Cape Chemical Society on the 22nd August 1924) By F Favier. Pp 8 (Pretoria Government Printing and Stationery Office)

Proceedings of the Royal Society of Victoria Vol 87 (New Series), Part 1, May 28th Pp iii+129+10 plates (Melbourne)

Loughborough College, Leicestershire Calendar, Session 1925-26 Pp xiv+120+40 plates (Loughborough) 2s 6d net

South Australia Department of Mines Mining Review for the Half-Year ended Dec 31st, 1924 (No 41) Pp 93+0 plates (Adelaide R E E Rogers)

Astronomical Papers prepared for the Use of the American Ephemeris and Nautical Almanac Vol 10, Part 1 Positions and Proper Motions of 1601 Standard Stars for the Equinox 1925.0. Pp 167 (Washington. Government Printing Office) 40 cents

Department of the Interior United States Geological Survey. Bulletin 750 Geology of the Bristol Quadangle, Creek County, Oklahoma, with Reference to Petroleum and Natural Gas By A E. Fath Pp. iv+103+18 plates 40 cents Bulletin 760-11 Pedestal Rocks in Strata Channeled By Kirk Bryan Pp. ii+128 180+plates, 31 32 Bulletin 763 Geology and Ore Deposits of the Arapahoe and Stanley Mining Districts, Graham County, Arizona By Clyde P Rogers Pp. vi+120+18 plates 25 cents (Washington Government Printing Office)

Department of the Interior Bureau of Education. Bulletin, 1924, No 31 Statistics of City School Systems, 1921-22 Prepared under the direction of Frank M Phillips Pp. ii+222 25 cents Bulletin, 1925, No 7 Kindergarten Legislation By Nina C Vandewalker Pp. iii+82 5 cents (Washington. Government Printing Office)

Department of the Interior United States Geological Survey Professional Paper 182-I Origin of the Hoghead Cones. (Shorter Contributions to General Geology, 1923-1924) By Reinhardt Tietze-Pan. Pp. ii+121-139+plates 27-40 Professional Paper 182-J Aniakchak Crater, Alaska Peninsula (Shorter Contributions to General Geology, 1923-1924) By Walter R Smith Pp. ii+139-140+plates 41-44 (Washington Government Printing Office)

Department of the Interior United States Geological Survey Water-Supply Paper 509, Surface Water Supply of the United States, 1914-1920 Part 8 Colorado River Basin Pp. v+260+2 plates 25 cents Water-Supply Paper 537 A Study of Coastal Ground Water, with Special Reference to Connecticut By John S Brown Pp. viii+101+7 plates, 20 cents Water-Supply Paper 500-B Chemical Character of Ground Water of the Northern Great Lakes By H B Ridenburg. Pp. ii+31-62 Water-Supply Paper 500 C Index of Analyses of Natural Waters in the United States By W D Collins and C S Howard Pp. ii+53-85 (Washington Government Printing Office)

Ministry of Finance, Egypt Survey of Egypt Geology of Egypt. Vol 1 The Surface Features of Egypt, their Determining Causes, and Relation to Geological Structure By Dr W F Illme Pp. xiv+408+122 plates (Cairo Government Publications Office) 50 P.T.

Mines Department Third Annual Report of the Safety in Mines Research Board, including a Note regarding Matters dealt with by the Health Advisory Committee, 1924. Pp 72 (London H M Stationery Office) 1s net

Ministry of Public Works, Egypt Physical Department The Climate of Alexandria By Mahmoud Hamel (Physical Department Paper No 19) Pp. iii+62+8 plates. (Cairo Government Publications Office) 5 P.T.

Memoirs of the Geological Survey of India Palaeontologia Indica. New Series, Vol. 8, Memoir No 3 The Palaeontologia of the Eocene of Burma By Dr Guy E Pilgrim Pp. iii+28+2 plates. (Calcutta Government of India Central Publication Branch) 1 rupee, 5-9d

Memoirs della Pont Accademia delle Scienze Nuovi Lincei. Serie Seconda. Volume Nottimo Pp. iv+200 (Roma)

Department of the Interior Bureau of Education Bulletin, 1925, No 14 Record of Current Educational Publications, comprising Publications received by the Bureau of Education to April 1, 1925 Pp. ii+50 (Washington Government Printing Office) 10 cents

Department of Commerce Bureau of Standards Scientific Papers of the Bureau of Standards, No. 500 Theory and Interpretation of Experiments on the Transmission of Sound through Partition Walls By Edgar Buckingham Pp. 191-210 (Washington Government Printing Office) 10 cents

Union Géodésique et Géophysique Internationale Deuxième assemblée générale, Madrid, Octobre 1924 Procès-verbaux des séances de la section de météorologie Pp 184 (Rome L'Imprimerie Pio Bellani)

Year Book of the Academy of Natural Sciences of Philadelphia for the Year ending December 31, 1924 Pp 98. (Philadelphia)

Imperial Department of Agriculture for the West Indies Report on the Agricultural Department, St. Lucia, 1923. Pp. iv+26 (St Lucia) 6d

Cambridge Observatory Annual Report of the Observatory Syndicate, 1924 May 19-1925 May 18 Pp 1 (Cambridge)

Department of Agriculture, Ceylon Bulletin No 72 The Control of Shot-Hole Borer of Tea (*Xyleborus forficatus*, Eichh) By F P Jepsou and Dr C. H. Gadd Pp. 46 (Peradeniya) 40 cents



SATURDAY, AUGUST 22, 1925.

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British Optical Instruments.

PROGRESS in nearly every branch of scientific investigation is dependent on the provision of suitable measuring apparatus. As the science develops, an ever-increasing degree of accuracy of measurement is required, which in its turn involves a correspondingly higher degree of refinement in the measuring apparatus. Many of the measuring instruments employed are essentially of an optical nature, and thus the optical instrument maker has been truly described as the tool-maker for all branches of scientific investigation including his own. It is the function and the duty of such a tool-maker to keep himself familiar with the latest advances in science, so as to be able to understand or even to anticipate the requirements of the investigator, and to meet these requirements by the provision of suitable practicable devices. That the British optical instrument maker has successfully fulfilled this function was clearly indicated by Mr. F. Twyman, who, in his recent presidential address to the British Optical Instrument Manufacturers' Association, discussed the capacity of the industry for invention, development, and production. His survey contained a record of notable achievements in regard to instrument design and construction of which any body of workers might justly be proud.

The economic stringency and the increased competition experienced during the past few years have stimulated the industry to increased efforts towards perfecting the quality and widening the range of its products, and towards improving and increasing its equipment for producing. Technically, the industry is in a healthy condition. Its research organisation, the British Scientific Instrument Research Association, has already proved of inestimable value. In addition, many of the individual firms in the industry actively prosecute research in their own laboratories; and these investigations are not simply directed towards putting forward new processes or improvements, but are often of a fundamental nature. This activity in research is reflected in the numbers of papers which have been published in recent years in the Transactions of the Optical Society and elsewhere, giving results of many important investigations carried out by the scientific staffs of optical firms. Educational facilities in all branches of technical optics are provided in London at the Optical Engineering and Applied Optics Department of the Imperial College of Science and at the Northampton Polytechnic Institute. Thus, the scientific, technical, and educational equipment of the industry is such as to lead one to anticipate a continuance of the notable attainments which have characterised it in the past.

The story of these achievements of the British optical instrument industry has never been sufficiently proclaimed, and the industry's commercial activities have probably not equalled, in extent or intensity, its technical and scientific abilities. For many years, German optical instruments have held a high reputation. This reputation has been well-deserved. It has been built primarily on quality; but quality has been backed up by publicity, by advertisement, and by efficient commercial methods which, above all, rendered the selection and purchase of a suitable instrument a relatively simple matter. To-day, the products of the optical glass industry and the optical instrument industry of Great Britain are well able to compete with those of any other country, and in many directions they have established a distinct supremacy.

If an examination were made of similar types of optical glasses obtained through the ordinary commercial channels from British and from foreign makers, we believe that the results would show that the former are in several respects superior to the latter. It is unfortunate that no detailed authoritative statement on this subject has yet been published. In regard to microscopes, the best British stands have been, for long, unsurpassed, and many notable advances have recently been made in the optical parts. British microscope manufacturers have now provided a series of apochromatic objectives which are superior to any made in any other country. They have also introduced improvements in illuminating systems, a dark-ground illuminator having been developed which permits the use of higher powers than was hitherto possible.

The superiority of British camera lenses has been frequently demonstrated. Photographic lenses for aerial survey, the specification for which is particularly severe, have been supplied to foreign countries by British makers in open competition with the rest of the world. The photographic lenses of aperture $F/2$ recently produced in Britain were the first lenses of such great rapidity, and are still distinctly the best of their class. The only foreign-made lens of an equivalent speed covers about two-thirds the width of field of the British lens. The telephoto lens, which originated in Britain, has been improved so as to suit the varied and extended uses to which it is now being applied, and the British lens of this type still holds a foremost place.

For astronomical instruments and for instruments used in astrophysics, no country stands higher in reputation than Great Britain. Since the War, British makers of surveying instruments have re-designed most of their instruments, and have effected improvements, not only in design, but also in construction and in sub-

sequent performance. The quality of the instruments is indicated by the fact that satisfactory sales are being effected abroad in the face of particularly severe competition from other countries. The best British binoculars now being manufactured are a little better than the best of the same class made abroad, and in addition, binoculars have now been made here which have a larger field of view than any others at present on the market.

For many years, the premier manufacturers of range-finders in the world have been British, and before the War, foreign governments were probably their best customers. During these latter years, these manufacturers have continued to develop and improve their products, which for quality and efficiency are still unsurpassed.

British optical instruments for physical research form another branch with a deservedly high reputation. Complete equipments for dealing in a broad way with various special fields of research, such as the electron theory of matter, have been supplied by British manufacturers to laboratories in practically every country in Europe, as well as to the United States of America, Japan, and various parts of the British Empire. It is probable that most of the research of the world in certain fields of prime importance in modern physics is being done with British-made instruments.

On its own initiative, the optical instrument industry during the past ten years has developed apparatus for the testing of optical elements and optical instruments. This apparatus, in one or other of its various forms, will measure interferometrically the errors and imperfections of any kind of optical instrument, such as, for example, an astronomical telescope, a microscope, camera lens, or binocular. Photographs of the imperfections can easily be obtained, and these constitute unquestionable records. The apparatus is now in use in Britain and also in certain factories and State testing institutions abroad. It is thus possible for manufacturers to have applied to their lenses a test which is free from all elements of judgment, and to have the results stated in numerical measurement.

Enough has been said to show that, from a technical point of view, the British optical instrument industry is active and vigorous. The existence of such an industry is vitally essential to progress in science and to the healthy development of the nation. Close co-operation between the scientific investigator and the optical instrument maker will facilitate a continuance of that progress and development. Reference may be made in this connexion to recent investigations on filter-passing micro-organisms. Adequate instrumental facilities for investigations on such organisms were not in existence a year or two ago. The investigators knew the limita-

tions of their apparatus and knew what their requirements were. They placed their knowledge and requirements before the instrument maker, and in a comparatively few months were supplied with the instruments which enabled them to go further and deeper into their work and to obtain those important results which have recently been published. The work involved the construction of a microscope stand with an accuracy of focussing and a rigidity not provided by any existing stand, and also of an entirely novel combined illuminator, in which a high aperture dark-ground illuminator is mounted concentrically with, and encircling, a quartz condenser. The former secures visibility and is used to locate the micro-organisms, while the latter is used with ultra-violet light to obtain the image on the photographic plate.

Many examples could be given of the services rendered by the optician in the provision of special apparatus, often very complex and ingeniously designed, for the control of industrial processes. The efficiency of the British optical instrument industry has been, to a large extent, responsible for the rapidly growing use of optical projection apparatus in connexion with industry.

It is obviously in the interests of the scientific investigator, whether his work lies in the academic or in the industrial field, that there should be in the country in which he works, a progressive and efficiently equipped optical instrument-making industry. Such an industry does not exist on the production of specialised instruments alone. The more frequently recurring demands for instruments of the less elaborate types have also to be met. The production of these provides training and experience for the members of the industry. Production is regulated by demand. The greater the demand for British-made optical instruments, even of the simpler type, the wider will be the field from which may be recruited the craftsmen, the artists, and the scientific designers, all of whom are required in the production of many of the masterpieces which emanate from the optician's workshop or laboratory.

The contributions made by the optical instrument industry of Great Britain both to science and to industry entitle it to support and encouragement by every section of the nation. During times of peaceful progress, as much as during war and strife, a prosperous and active optical instrument industry is an important national asset, the influence of which may extend far beyond mere national boundaries. It should only be necessary for the users in Great Britain of optical instruments to be made fully aware of the industry's attainments and capabilities, and also of the range and quality of its productions, to ensure that such support and encouragement will not be lacking.

Modern Physics.

- (1) *Die Methoden der theoretischen Physik.* Von Felix Auerbach. Pp. x + 436. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1925.) 13 gold marks.
- (2) *Introduction to Theoretical Physics.* By Prof. Arthur Haas. Translated from the third and fourth editions by T. Verschoyle. Vol. I. Pp. xiv + 331. (London, Bombay and Sydney: Constable and Co., Ltd., 1924.) 21s. net.
- (3) *Physics: a Text-book for Colleges.* By Prof. Oscar M. Stewart. Pp. viii + 723. (Boston and London: Ginn and Co., 1924.) 17s. 6d. net.
- (4) *Lehrbuch der Physik in elementarer Darstellung.* Von Arnold Berliner. Dritte Auflage. Pp. x + 645. (Berlin: Julius Springer, 1924.) 18-60 gold marks.

IN the older British universities the term natural philosophy is still used to denote one of the main branches of study. In 1747 we find Mr. David Young appointed to be "professor of natural and experimental philosophy" in the United College of St. Salvator and St. Leonard in the University of St. Andrews. In the Scottish universities, applied mathematics fell within the province of the department of natural philosophy. There lies before us an M.A. diploma of the University of Glasgow, dated 1863, signed, amongst others, by Gul. Thomson, *Phil. Nat. Prof.* There is something to be said for retaining the more sonorous designation natural philosophy, at least for official purposes, in preference to the more compact term physics. It is the science which treats of the general properties of natural bodies. "The philosophy of science," says Prof. Whitehead, "is the endeavour to formulate the most general character of things observed." The changes which have taken place in our outlook upon natural phenomena during the first quarter of the present century have been profound, but yet they must be described as evolutionary rather than as revolutionary in character. Not only have there been brilliant experimental discoveries, resulting in entirely new methods of investigation, but also during the same period new theoretical conceptions have been introduced by Planck, Einstein, and Bohr, which have led to much questioning as to the fundamentals of our philosophy.

These developments, which have been discussed in a very large number of special treatises, have tended to render many of the older text-books, if not obsolete, at least imperfect and incomplete. The time has now arrived when it appears necessary to make provision for the new knowledge by revised and extended treatment. The task is no easy one, partly because of the rapid accumulation of new material and partly on account of our imperfect grasp of the new theories

Another and very serious difficulty is the amount of mathematical knowledge and training required for the full appreciation of old and new theories alike. As Prof. Donnan says in his foreword to the volume by Prof. Haas:

"A sure understanding of the quantitative principles of physical science is nowadays a necessity for everybody—for the chemist, engineer, and physiologist as much as for the physicist. Nobody can afford to say that he is not a physicist and so expect to be forgiven for his ignorance. Nevertheless, the difficulty is a real enough one for the many who fear the mathematical reasoning and the wealth and subtlety of physical science."

This raises the important question of the relation between the teaching of mathematics and the teaching of physics. If, as is now the custom in most, if not all, British universities, the teaching of each subject is undertaken by a separate department, it is clearly desirable that the teacher of applied mathematics should be in sympathy with the experimental work of the science student, and if possible be himself in some sense an experimenter. To the reviewer, who has had experience of the Mathematical Tripos of former days, it seems only a truism to say that in a well-arranged university course the mathematical and experimental work should proceed side by side, acting and reacting upon each other to the mutual advantage of both.

In the Rouse Ball Lecture for 1924, Dr. Horace Lamb has emphasised the condition for mathematical progress stated by Fourier: "The profound study of Nature is the most fruitful source of mathematical discoveries." The tendency, which has unfortunately prevailed at Cambridge, to separate mathematics and physics into watertight compartments, must be strenuously resisted.¹ The same may be said, in perhaps lesser degree, of other branches of science.

(1) The problem referred to above has been encountered by Dr. Auerbach, of Jena, who states that his experience proves that a student who attends without preparation courses on the special branches of theoretical physics (mechanics, heat, electricity, optics) does not appreciate the meaning of the whole or understand the methods employed in obtaining the results. On the other hand, he found that an introductory methodical course (largely concerned with mathematical processes) attracted a large number of students, who afterwards attended special courses with much greater benefit. This volume is the outcome of such a preparatory course of lectures. The author starts with the fundamental principles and then proceeds to deal systematically with the methods, passing from ordinary language to the language of mathematics, from the elementary to the more advanced, from the infinitesimal to the statistical, from

the arithmetical to the geometrical. Examples illustrating the mathematical methods are drawn from all branches of physics. The resulting impression conveyed is that of a rearranged text-book of physics in which the subjects are now grouped so that each individual experiment or theoretical investigation serves as an illustration of a particular type of mathematical equation or method. Thus cubic equations are illustrated by the example of the equation of state of Van der Waals, maxima and minima by the greatest range of a projectile and the position of minimum deviation of a prism.

If the point of view taken by the author be conceded, the resulting treatise may be regarded as satisfactory, for the work has been well done and the exposition is clear. The title chosen is slightly misleading, as it does not convey to the casual reader the fact that by far the most important function of the book is to elucidate mathematical methods in their physical applications. In a book of this character dealing with complex functions, differential equations, and spherical harmonics, it is remarkable that vector methods are not introduced until page 407 is reached.

(2) In writing his text-book, Prof. Haas, of Vienna, states that his aim is to provide an exposition which, while modern in treatment and outlook, would give a survey of the present state of theoretical physics, its principles and problems, without going too far into details. On looking over the pages for the first time, it might be inferred that this was a book for the mathematical physicist. It is true that symbolic and vectorial methods are employed and the principal rules of differential and integral calculus are assumed, but let the non-mathematician take heart—he is led on by gradual stages from the more familiar to the more abstruse. Prof. Haas is a skilful teacher, and the earnest student who follows him with care should finish the volume with greatly widened knowledge and sincere appreciation of the help rendered. To quote again from the foreword by Prof. Donnan: "The whole structure of physical theory is built up piece by piece, with an exposition so sequent and crystal clear that we can pass through and understand the great luminous building without painful effort." This first volume deals with mechanics, with the general theory of vector fields, of vibrations, and of potential, and also with the theory of the electromagnetic field and of light. The important subject of atomistic physics is postponed to later volumes. In an appendix of 20 pages a convenient summary is given of the contents of Vol. I.

An eminent exponent of the principle of relativity is credited with the dark saying that the mathematician is never so happy as when he does not know

¹ See NATURE, vol. 114, p. 460, 1924.

what he is talking about! He rejoices in the breadth of his generalisations and may say with the poet:

"There are nine and sixty ways of constructing tribal lays,

And every single one of them is right."

Perhaps! But the historian may attach very different values to them as accurate or even approximate records of tribal history. It is often difficult to determine at what point in a mathematical argument some tacit assumption is made, the rejection of which would invalidate the subsequent reasoning. As a rule, Prof. Haas is very careful in this matter, but consider the statement on page 211: "It is *impossible* for a *single magnetic source to exist* by itself" (italics as in the original). This is said to be a fact which necessarily follows from the definition of magnetism. Doubtless—if the author's definition is accepted; but should the physicist isolate a magnetic pole to-morrow, the mathematician would have no difficulty in formulating a new definition of magnetism.

(3) The college text-book of physics by Prof. Stewart is of a more elementary character and does not call for detailed criticism. It should prove suitable for students who expect to specialise in agriculture or medicine, or for those who are taking physics as part of a general course in arts and science. The author realises that there is a more important purpose than that of merely giving useful information. "The great discoveries and applications of science, to which we are to-day so indebted, have been due primarily to the development and diffusion of what may be called the modern scientific method of reasoning. The study of physics offers unusual opportunity for acquiring this method." Stress is laid on the importance of grasping the fundamental principles of the subject; but only after the student has had the opportunity of becoming familiar with the facts, are deductions or generalisations made. The principles are illustrated by a large number of examples drawn from common experience. An interesting and valuable feature is the introduction of a chapter on meteorology, "the physics of the atmosphere," with special reference to the United States and Canada. The volume is well illustrated and is liberally provided with numerical problems.

(4) Dr. Arnold Berliner, editor of *Die Naturwissenschaften*, has faced and accomplished successfully the difficult task of revising his "Lehrbuch der Physik," which now appears in a third and enlarged edition. The author acknowledges his indebtedness to Profs. Geiger and Henning for assistance in dealing with the subjects of atomic physics, radioactivity, and heat. The amount of information contained in these 645 quarto pages, many of them closely printed, is extraordinary. The standard is about the same as that of

Ganot or Deschanel, but the range is wider, and modern work is discussed from the beginning of the book. As illustrating the mixture of old and new, we may note that the quantum theory of specific heat comes only six pages later than the description of Lavoisier's ice-calorimeter; a few pages further on follows a well-illustrated account of the steam turbine.

The author realises clearly the restrictions imposed upon him by the elementary character of the work. While this makes a certain breadth of treatment—even amounting to prolixity—inevitable, it demands many sacrifices as regards strictness of demonstration and fullness of detail. The stringent claims of the professional physicist must sometimes be disregarded, and on didactic grounds only what is essential must be retained. It is remarkable, however, how much can be accomplished without the employment of advanced mathematical methods. Not many authors, for example, would care to face the task of presenting in some half-dozen pages an outline of both the special and the general theory of relativity. It is open to question whether the author is justified in adopting the bold plan of stating the principles of thermodynamics, including Nernst's heat theorem, before giving an account of the fundamental methods of thermometry and calorimetry.

British physicists are, as a rule, generously treated, and quotations are made from the writings of Faraday, Maxwell and Tyndall; but it may be pointed out that, long before Helmholtz in a celebrated memorial lecture emphasised the work of Faraday, the latter had formed a clear conception of the existence of atoms of electricity. The sections dealing with the development of the electron theory deserve a special word of praise; these take up in turn the subjects of discharge in gases and the phenomena of ionisation, Röntgen radiation, radioactivity, and the structure of the atom. In the last-named section a very lucid and interesting picture is given of the atomic model due to Rutherford and Bohr, together with a short account of its application to the explanation of the hydrogen spectrum. The work of Moseley on X-ray spectra and that of Aston on isotopes is briefly described, and Einstein's photo-electric equation is discussed. The numerous diagrams, though reproduced on a small scale, are remarkably clear and add greatly to the value of the book.

Of special interest is the chronological table which fills the last three pages of the volume. This contains the names of the leading natural philosophers of all nations from A.D. 1500 to the present time, and shows at a glance the life-period and the contemporaries of each. Such a table in the form of a wall-chart would be invaluable in the lecture-room of any department of physics.

H. S. ALLEN.

Our Climatic Environment.

- (1) *Civilisation and Climate*. By Ellsworth Huntington. Third edition, revised and rewritten, with many new chapters. Pp. xix + 453. (New Haven: Yale University Press; London: Oxford University Press, 1924.) 23s. net.
- (2) *Principles of Human Geography*. By Ellsworth Huntington and Sumner W. Cushing. (Huntington Geography Series.) Third edition, revised. Pp. xviii + 430. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 15s. net.
- (3) *Climatic Laws: Ninety Generalisations with numerous Corollaries as to the Geographic Distribution of Temperature, Wind, Moisture, etc.; a Summary of Climate*. By Prof. S. S. Visser. Pp. 96. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 7s. 6d. net.

(1) FROM archæological studies in Asia and Central America, Prof. Ellsworth Huntington was convinced that at certain periods in the past the population of these regions was not only larger than at present, but also more energetic and progressive. He also found evidence that in the arid parts of Asia these more populous periods were blessed with a greater rainfall. Hence he developed the "pulsatory" hypothesis of climatic changes. This hypothesis has met with a considerable amount of criticism, the most obvious of the alternative views being that with proper irrigation the land is still capable of supporting a large population, and that the inhabitants have to thank their idleness and improvidence, or the lack of enlightened government, for conversion of their fields into deserts. It must be agreed that the present inhabitants of Mesopotamia or the Indians of Central America would provide very poor stuff on which to build up a great empire like those of antiquity. Huntington has frankly admitted the point, and has turned the tables on his critics by making the variation of human efficiency with changes of climate an essential part of his theories. In so doing he has achieved a great deal of useful work in what may be termed the science of "applied climatology."

The first edition of "Civilisation and Climate" appeared in 1916, and opened with a detailed analysis of the amount of work done under different climatic conditions by a number of groups of people, mainly in the United States. The conclusion arrived at was that the most favourable conditions for human efficiency were a mean temperature in the neighbourhood of 60° F., a moderate seasonal range, a moderate variability of temperature from day to day, and a considerable degree of "storminess," the latter condition providing a stimulating series of weather changes. The material

was good so far as it went, but being based mainly on a single country within the north temperate belt, it did not seem to provide a sufficient groundwork for a discussion ranging from the tropics nearly to the poles. In the third edition, the basis has been extended by a detailed discussion of the death rates in a number of large towns, in relation to daily and seasonal changes of weather.

The results confirm those obtained from measurements of work done under varying conditions, but the basis is still predominantly American. The mean annual temperature of the eastern United States ranges from about 50° F. in the north to 70° F. in the south, and the optimum temperatures for health and physical energy range from 58° F. in Connecticut to 68° F. in Florida. For mental energy the optimum is lower, but the data are few and incomplete. In the north, where buildings are warmed in winter, the average annual temperature in which people live is higher than the mean temperature of the open air, so that the conclusion can legitimately be drawn from Huntington's figures that people are healthiest and work best in the temperatures to which they are most accustomed. One would like to see this part of the book extended to include the work of native races in the tropics and in the far north, but it is admitted that the necessary data would be hard to obtain. The other climatic factors of efficiency, variability of temperature and weather, are not open to this objection to quite the same extent, and there seems to be no doubt that these factors are responsible for small variations of 2 or 3, perhaps 5 per cent. in the output of work. Whether these variations are large enough to be significant in human progress remains doubtful.

On the basis of the results for temperate eastern America, the author proceeds to calculate the energy value of the climate of each part of the globe. The formula employed is arbitrary, and perhaps assigns too much importance to temperature, but granting the initial assumption that the climate of New England is highly favourable, it appears to fulfil its purpose sufficiently well. This map of climatic energy is compared with a map of "civilisation," according to the opinions of fifty competent authorities. The agreement of the two maps is striking, and really forms the main justification for the book.

The concluding chapters deal with the civilisations of antiquity, and the opinion is expressed that they grew up along the storm belt when it lay much farther south than now. But in the efficiency formula the temperature terms predominate, and since these have admittedly not changed appreciably, this amounts to an assumption that the optimum temperature was also higher; in other words, that the needs of the human

species have changed since that date. Hence it seems that the effects of storminess and especially of rainfall need to be considered in greater detail, and quite apart from temperature. Criticisms such as these are, however, matters of detail; the book certainly succeeds in its main object, which is to bring out the importance of climate in human activity and well-being. It remains only to add that it makes very interesting reading and is well illustrated, while the general appearance is excellent.

(2) The "Principles of Human Geography" is a text-book dealing with the relation of man's activities to the environment in which he lives. The first nine chapters deal with the more strictly geographical aspect—latitude, land-forms, bodies of water, soil, minerals and sources of power—and show how these control human life in different regions. The remainder of the book deals with the influence of climate, through its effect on plants and animals and on human efficiency, according to the views of "Civilisation and Climate."

Each of the different climatic regions has its own series of plant and animal products and its especial climatic advantages and handicaps. In the regions where the "climatic energy" is least, man is the slave of his environment, while in more favourable climates he begins to overcome his handicaps and improve his opportunities. In this way arise a number of characteristic cultures, which are skilfully described and analysed. Finally we come to the regions of cyclonic storms, the fortunate inhabitants of which rise superior to their environment, reaching out to the ends of the earth to gather the products of all countries, and to dominate their weaker neighbours, and the last few chapters may be described as the epic of "cyclonic man."

The authors have kept a restrained and lucid style throughout, while the book is well printed and illustrated. Each chapter concludes with a series of interesting problems requiring independent research, and one can readily accept the authors' statement that the students tackle them with great enthusiasm and interest.

(3) "Climatic Laws," unlike the two preceding books, appears to be the result, not of original thinking, but of much reading. It presents ninety generalisations, which are considered to correspond with the "laws" of other sciences. The idea is good, but the author's methods result in a heterogeneous mixture of dogmatic statements. Some are so obvious that it does not seem necessary to commit them to writing (e.g. the "law" that days and nights vary in length in middle and high latitudes); some are not true (e.g. "There are for most places two diurnal maxima and two minima for precipitation. . . . The maxima usually are at 2-5 P.M.

and 3-6 A.M."); the remainder are useful summaries of facts. The book is also marred by several examples of loose writing. Its most valuable feature is the long list of references, but the author would have been well advised to quote more extensively than he has done and also to add a few pages of tables.

The Tetraphyllid Cestodes.

A Monograph on the Tetraphyllidea: with Notes on related Cestodes. By Dr. T. Southwell. (Liverpool School of Tropical Medicine. Memoir (New Series) No. 2.) Pp. xv + 368. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1925.) 20s. net.

THE most difficult group of helminth parasites to deal with from the morphological point of view is the Cestoda. They have superficially a very considerable resemblance to each other and an elaborate technique is necessary before their internal anatomy can be satisfactorily studied. The older naturalists in their classifications based their systems largely on the external characters—characters which in a colourless animal such as a tapeworm are unsatisfactory, and are rendered even more unsatisfactory by the extremely muscular nature of the parasite and the absence of any supporting skeleton to retain a permanent shape. Moreover, the complicated life-cycle of these animals has made confusion worse confounded and our knowledge of the whole group is in a very chaotic condition indeed.

At present four orders of Cestoda are generally recognised. These are (1) the Cyclophyllidea, which contains most of the common forms from mammals and birds and on that account has had the greatest amount of attention; (2) the Pseudophyllidea, which includes the Broad tapeworm of man and has recently been the subject of a monograph by Nybelin; (3) the Trypanorhyncha, which is at present in a state of the utmost confusion; and (4) the Tetraphyllidea, which is the subject of the present able monograph. To these four Dr. Southwell has added a fifth and smaller order, the Heterophyllidea. This new order is considered exhaustively in the present work.

Dr. Southwell has been engaged in the study of the cestodes of fish for about sixteen years—especially in connexion with the Ceylon Pearl Fisheries and as Director of Fisheries in India—and the present volume is the result of that research. This work, supplemented by a recent paper on the Tetrarhynchids (the Tetrarhynchidae is one of the two families composing the Trypanorhyncha) found in Ceylon Marine Fishes (*Ann. Trop. Med. and Paras.*, 1924, 18, pp. 459-491), forms a complete monograph on the cestodes of fish.

This volume consists of four parts, of which the first is of more general interest than the others. It is devoted mostly to a critical examination of the present systems of classification of the whole group. Dr. Southwell believes that the five orders can only be separated naturally by means of the shape of the head. Thus the Cyclophyllidea have four suckers, the Pseudophyllidea either one (rarely) or two (commonly) bothria or sucking grooves, the Tetrephyllidea have four lappet-like outgrowths from the head called bothridia, while the Trypanorhyncha have four proboscides each of which is armed with spines. Forms which cannot be included in any of these four are referred to his new order, the Heterophyllidea. The Cyclophyllidea he proposes dividing into two sub-orders. The first of these, the Univittellata, which is equivalent to Stiles' superfamily Tænioidea, is characterised by the possession of a single unpaired vitelline gland. The second sub-order, the Multivittellata, has more than one yolk-gland and contains the Proteocephalidæ and the Lecanicephalidæ of Bräun. While no system of classification in a subject so imperfectly known as this one can be regarded as permanent, this scheme, even in the light of our present knowledge, is not fully satisfactory. Where in it, for example, can we place the genus *Mesocetoides*? This genus consists of forms with a four-suckered head and a typical Cyclophyllidean anatomy; but the genital opening is ventral, not lateral as in most forms of this order, and there are *two* discrete vitelline glands in a postero-median situation. It does not seem to find a place in Dr. Southwell's scheme. It is so obviously a close relation to the Tænoidean cestodes that it would seem that Dr. Southwell's Univittellata will have to be modified to include it.

The remaining three parts are of interest more to the specialist than to the more general zoologist or parasitologist. Part ii. deals with the Tetrephyllidea, part iii. with the Cyclophyllidea in fish, and part iv. with the Heterophyllidea. These sections, which are illustrated with nearly 250 drawings, discuss in a lucid and exhaustive manner all the forms belonging to these orders found in fish. Apart from the fact that future workers are now provided with modern and comprehensive accounts of these parasites, Dr. Southwell has rendered a very considerable service to science by greatly reducing the number of described species.

The task which Dr. Southwell had set himself was one of great difficulty: the result is a work highly creditable to himself and a contribution of considerable value to zoology.

The volume is introduced by a very characteristic foreword by Sir Arthur Shipley, and forms the second of the series of memoirs being published by the Liverpool School of Tropical Medicine.

The Internal Combustion Engine.

- (1) *Automobile Engines in Theory, Design, Construction, Operation, Testing and Maintenance.* By Arthur W. Judge. (Motor Manuals: a Series for all Motor Owners and Users, vol. 1.) Pp. vii+189. (London: Chapman and Hall, Ltd., 1925.) 4s. net.
- (2) *The Testing of High-Speed Internal Combustion Engines: with Special Reference to Automobile and Aircraft Types and to the Testing of Automobiles.* By Arthur W. Judge. Pp. xvi+392+54 plates. (London: Chapman and Hall, Ltd., 1924.) 25s. net.
- (3) *Cost of Power Production by Internal Combustion Engines.* By G. A. Burls. Pp. iv+56. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1924.) 5s. net.

(1) THERE is something to be said for the point of view that an elementary book on the internal combustion engine should really be an elementary book on the heat engine and should therefore contain an account of the steam engine in addition to those basic principles of the theory of heat which are common to both forms of prime mover. But in practice some differentiation is very usual; the number of readers interested in one is so vastly greater than the number interested in the other. Mr. Judge's book, which appears as one of a series specially written for "all motor users and owners" is an example of this.

We should at one time have expected to find a good proportion of motor owners but ill-equipped for the reading of such a book as Mr. Judge's, but the intense interest taken by a very large section of the public in the technicalities of radio broadcasting shows that we must be prepared to enlarge our ideas as to the receptiveness of the general public to technical writings. If this receptiveness applies now, or can be made to apply hereafter, to the study of automobile engines, Mr. Judge's book should prove to have achieved its object. It contains a great mass of information of the familiar type, and it presents it in a convenient and orderly form. The subject-matter is brought up-to-date; for example, the methods of supercharging automobile and aero engines are described, as are also the features of the modern anti-detonation substances for admixture with ordinary engine fuel.

(2) This book, also from the pen of Mr. Judge, is a very complete statement of the technics of the testing of high-speed internal combustion engines. In the course of its high on four hundred pages, the requirements of manufacturers, of inspectors and of laboratory assistants, appear equally to be met, but it is scarcely a book for general reading: those, however, whose work leads them to consult it will be grateful to the author for the painstaking way in which he has

collected information dealing with every aspect of testing, whether relating to stationary engines, automobile engines, or aircraft power plant.

(3) Mr. Burls is well known as a capable writer on the subject of the internal combustion engine, and we received with interest his new volume on the cost of power production by these engines. The period of time covered by this inquiry, as the author points out, includes that of the War, and many of the figures given are of special interest as showing the rapid increase in costs as hostilities proceeded, and the subsequent slow decline as the world gradually returned towards peaceful conditions. Apart from this, there is the factor that if the interest taken in this engine is to bear fruit, it is necessary that information giving up-to-date figures of capital and working costs, particularly in comparison with other forms of power production, shall be ready to hand. It is rather a shock to notice on p. 44 of this new book that some of the statistics go no later in date than June 1921, although on the same page there is other information dated August 1924.

An especially interesting point is made by the author when dealing with the power capacity of large gas engines. He quotes Sir Dugald Clerk's view of the limiting factor in terms of heat units per cubic foot of piston displacement, and shows that this is much better expressed as a limiting mean effective pressure on the basis of a constant thermal efficiency. As applied to the large gas engine, this leads to the range of 55 to 65 lb. per square inch, and the author quotes 64 lb. as representing current practice in 1924. This makes a bulky installation compared with that of a steam plant, and unless it were for the great difference in the average over-all thermal economy (as 15 per cent. is to, say, 8.5 per cent.) the internal combustion engine would come badly out of such a comparison.

Mr. Burl's book will be of very real use to the engineering profession.

Fossil Man.

Human Origins: a Manual of Prehistory. By Dr. George Grant MacCurdy. Vol. 1: The Old Stone Age and the Dawn of Man and his Arts. Pp. xxxviii + 440. Vol. 2: The New Stone Age and the Ages of Bronze and Iron. Pp. xvi + 516. (New York and London: D. Appleton and Co., 1924) 42s. net.

DURING the past thirty years Dr. MacCurdy has paid frequent visits to the Old World to study on the spot the various discoveries of prehistoric man and his handiwork. For some time he has also directed the American School of Prehistoric Research in Europe. He has taken part in several diggings, notably in the

exploration of the cave of La Combe (Dordogne) by the Peabody Museum of Yale University in 1912. He is curator of anthropology in this museum, and has had much experience in teaching. Dr. MacCurdy is therefore well qualified to produce a students' manual of prehistory with first-hand information, and his two handsome volumes now before us will be widely welcomed. He is cautious—perhaps too cautious—in expressing opinions of his own, but his work is most exhaustive in summarising the conclusions of the authors quoted by him. He has discussed the various subjects with most of these authors, and so is able to present them to the student in the most satisfactory manner.

The first volume begins with a useful glossary, and the second ends with tables of the stratigraphy of palæolithic sites, a repertory of palæolithic art, and a list of the prehistoric monuments of France. Numerous authoritative synoptic tables, besides bibliographies, are also scattered through the text. Dr. MacCurdy has thus provided not only a readable story, with excellent illustrations, but also a work of reference of the greatest value.

After a brief history of the development of prehistoric chronology, there is the usual attempt to correlate the successive races of palæolithic man with the various phases of the ice age which are recognised in the Alps. Late glacial and postglacial time is measured by discoveries in the geology of Scandinavia. The extent of the ice-sheet at the successive periods is shown in a new map which has been compiled from many sources. The handiwork of eolithic and palæolithic man is then treated in several chapters, which are illustrated by photographs of sites taken by the author and by numerous new figures of stone implements in the Yale University collection. Finally, the known remains of the skeleton of palæolithic man are briefly described, with numerous illustrations. Dr. MacCurdy is careful to emphasise the doubts about several specimens of which the antiquity is very uncertain, and he emphatically rejects the discoveries of Ameghino in South America.

A whole chapter is devoted to the Azilian and other stages which belong to the interval between the palæolithic and neolithic periods. Their wide geographical distribution seems surprising when they are tabulated on Dr. MacCurdy's plan. The neolithic period is then concisely treated from every point of view, concluding with an account of the megalithic monuments. There is, however, no allusion to the temples in Malta which have been described as of neolithic age. Fire, hunting, fishing, navigation, the wheel, the domestication of animals and plants, commerce, healing, and magic or religion during the stone

age are then considered in general; and the work concludes with some account of the ages of bronze and iron.

Among the numerous treatises on prehistoric man which have appeared during recent years, the new one of Dr. MacCurdy is assured of a high place, and we cordially recommend it to the notice of all serious students.

A. S. W.

Our Bookshelf.

University of London: Francis Galton Laboratory for National Eugenics. Eugenics Laboratory Memoirs, 22: The Treasury of Human Inheritance. Edited by Karl Pearson. Vol 3: *Hereditary Disorders of Bone Development.* Part 1: *Diaphysial Aclasis (Multiple Exostoses), Multiple Enchondromata, Cleido-Cranial Dysostosis*, by Dr. Percy Stocks; with the Assistance of Amy Barrington. Pp. vi + 182 + 16 plates. (Cambridge: At the University Press, 1925.) 45s. net.

OF the twenty-two valuable memoirs issued by the Francis Galton Laboratory for National Eugenics, eight form part of the "Treasury of Human Inheritance." These Treasury memoirs deal exhaustively with inborn anomalies, disorders of growth or pathological conditions, all of which may pass from parent to offspring and therefore afford opportunities of studying the laws of heredity as they affect man. Former memoirs have been devoted to anomalies of the foot and hand, to cleft palate, hare-lip, deaf-mutism, imperfect differentiation of sex, hæmophilia, dwarfism and anomalies of the eye; the memoir under notice, the eighth of the Treasury series, deals with those disorders in the growth of bones known to medical men under the names of *Diaphysial aclasis* (multiple exostoses) and *Cleido-cranial dysostosis*.

The present memoir, for which Dr. Percy Stocks is mainly responsible, maintains the high standard set by former numbers of the series; it will remain for many a day the source from which students and experts must draw information concerning some of the most obscure disorders which overtake the bones of growing children. *Diaphysial aclasis* affects chiefly the growing ends of the long bones. Dr. Stocks has found 976 cases of this disorder in medical literature; 183 families gave rise to 765 cases; there was evidence of heredity in 69.6 per cent. of the cases tabulated. Transmission is stronger through the male than through the female. Another, but rarer, disorder of growing bones is also dealt with, namely, multiple enchondromata, which may be associated with *diaphysial aclasis*, and is certainly related to it in nature. In the condition known as *cleido-cranial dysostosis* there is a partial failure in the formation of the clavicle, and with this there is usually associated an irregular formation of the vault of the skull. Records of 144 cases of this disorder have been collected; the condition was familial in 96 instances.

Prof. Karl Pearson is rendering a most valuable service to all students of the human body by securing the preparation and publication of these memoirs, and it would be a thousand pities if the series were to come to a premature end for lack of public support.

Handbuch der Zoologie: eine Naturgeschichte der Stamme des Tierreiches. Begründet von Prof. Dr. Willy Küenthal. Herausgegeben von Dr. Thilo Krumbach. Erster Band: Protozoa, Porifera, Coelenterata, Mesozoa. Vierte Lieferung. Pp. 513-608. 5.40 gold marks. Fünfte Lieferung. Pp. 609-736. 7.20 gold marks. (Berlin und Leipzig: Walter de Gruyter und Co., 1925.)

THE greater part (pp. 522-686) of these two sections of the *Handbuch* is devoted to an account of the Scyphozoa contributed by Prof. T. Krumbach, of Berlin. He defines the class and gives a short history of the Scyphozoa, in the concluding paragraph of which he refers to the *Tessera princeps* of Haeckel and remarks that this owed its existence to Haeckel's need for a primitive form which, however, never existed in life. The *Tesserantiha connectens* of Haeckel is a larval form of the imperfectly known rhizostome *Leonura*, and a similar larval form is known in the genus *Cassiopea*. The author describes each of the five orders of Scyphozoa, beginning with the *Lucernariida* and ending with the *Rhizostomeæ*, giving under each a definition, a short history, the characters of the principal genera illustrated by schematic diagrams, accounts of the morphology, development, and physiology, references to recorded abnormalities, and brief discussions of the ecology, geographical distribution (with maps), and phylogeny. Appended to each section is a useful bibliography of the order.

Under the order *Coronata* is an excellent account of the strange genus *Tetraplatia*, but the author is careful to point out that there is not sufficient evidence to establish the relationships of this genus.

This is an admirable memoir on the structure, biology, and physiology of the Scyphozoa, and the author is to be congratulated on having brought it, including the references to published works, so well up-to-date—the MS. was closed on December 28, 1924. While the account is well illustrated, there are lacking a few figures which would have been helpful to the reader, e.g. of the remarkable tentaculocysts of *Charybdea* and the tentaculocyst of the adult *Aurelia*.

The remainder of the fifth Lieferung contains a portion of the description of the *Octocorallia* by the late Prof. W. Küenthal—one of the outstanding authorities on this sub-class—and he has given a worthy account of the orders *Alcyonaria* (*Alcyonacea*) and *Gorgonaria* (*Gorgonacea*).

The Subject Index to Periodicals, 1921. Issued by the Library Association. K: Science and Technology. Pp. 126. (London: Grafton and Co., 1924.) 21s. net.

THE Library Association has issued a new instalment of its valuable Subject Index to the periodical literature of science and technology. The section covers the literature published in 1921 but contains some papers of earlier date. There are about 6000 entries obtained from the examination of 290 periodicals.

The periodicals selected are, for the most part, those printed in the English language, being published in the British Empire or in the United States of America. We notice, however, that titles in French and German have been taken from the following periodicals: *Bulletin de la Société pour l'Encouragement de l'Industrie nationale*, *Revue des Deux Mondes*, *Scientia*, *Journal*

Économique, Chemiker-Zeitung, Physikalische Zeitschrift, Sitzungsberichte der Preussischen Akademie, Forschungsarbeiten des Ingenieurwesens, Gewerbeblatt, Zeitschrift des Vereins der Ingenieure, Zeitschrift für historische Waffenkunde, Preussisches Lehrbuch, Zeitschrift für Reproduktionstechnik, and Veröffentlichungen des Militär-Sanitätswesens. This list of foreign periodicals consulted is taken from the first half only of the index which extends to 252 columns, and must not be taken as exhaustive, but it does suggest the question as to whether the Library Association could not see its way to include a greater number of foreign papers in its subject indexes.

The range of subjects catalogued in this section is so wide that any one interested in science will find his own branch of study dealt with under many of the headings, which are arranged in alphabetical order. A few such headings may be quoted as examples: Aeronautics, airships, alloys, aluminium, artillery, atoms, petroleum, relativity, ship propulsion, spectrum, wireless telephones, thermionic valves, vitamins, and parasitic worms. It would be impossible to include every scientific paper published in 1921 without making the list too bulky and too expensive for ordinary subscribers, so that a selection has had to be made.

It will be evident that the compilers of this index must have had great difficulty in deciding what papers should be included and which excluded. We think they have exercised a wise judgment in their selection.

Studies in Ampullaria. By E. G. Alderson. Pp. xx + 102 + 19 plates. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1925.) 21s. net.

THE scope of the work under notice is not what the author originally intended it should be. He had hoped to produce a complete monograph of the genus, but the necessary material could not be got together and Mr. Alderson has unfortunately made use solely of shells in his own possession. This is a very great pity, for the subject even thus restricted has been so ably handled that the wider work would have been warmly welcomed by conchologists—we cannot say malacologists, since all allusions to anatomy and ecology are rigidly excluded.

The author candidly admits that Bolten's name of *Pila* for the genus, or at all events a section thereof, has priority over Lamarck's, and so by the Rules for Zoological Nomenclature should be employed, but seeks to justify his preference by the stale excuse that *Ampullaria* is the more familiar name; thus he misses his chance of assisting in forwarding the cause of uniformity in nomenclature in the sole way in which it can be attained.

The work opens with a full and carefully compiled "Critical Bibliography," which in itself is of great value, but by a strange oversight omits Dall's important proposed classification published in 1904, although one of Dall's names is incidentally referred to later on. Then, after a brief "Introduction," the systematic descriptions of the species follow, each accompanied by a synonymy which seems to have been very thoroughly worked out. Any shortcomings that there may be in a work of this technical character will only reveal themselves to the student who uses it. The nineteen plates of figures, reproduced by half-tone

process from the author's own drawings, are exceedingly good: they are plain, but a limited edition of fifteen coloured copies is announced. The printing and general appearance of the book are admirable.

The Platinum Metals. By Ernest A. Smith. (Pitman's Common Commodities and Industries Series.) Pp. xii + 123. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 3s. net.

MR. ERNEST A. SMITH has produced a useful little work upon platinum and the metals associated with it, though it must be admitted that the latter receive but little, most people will probably say too little, attention. Some of them, such as iridium and palladium, deserve considerably more consideration than the book before us has given to them. Upon the whole the work may be described as accurate, although the author has not availed himself so fully as he might have done of previously published and readily available information. For example, his description of methods used in the Urals for working and washing the platiniferous gravels shows a good many omissions, which a more careful study of existing literature would have avoided.

Interest in platinum has been stimulated greatly within the last few years by the sensational discoveries in the Transvaal, though it cannot be said that the economic importance of these is even now at all known. Mr. Smith's book was written in 1924, and it is therefore no fault of his that it contains nothing more than a casual reference to the occurrence of platinum in the veins in the Waterberg district of the Transvaal. It was only towards the end of 1924 that the discoveries, possibly likely to be fraught with much greater importance, of the occurrence of platinum in the western part of the Lydenburg district were made, and these have only been quite recently described, as for example in two important papers by Dr. P. A. Wagner in the Transactions of the Geological Society of South Africa for 1925, and the *South African Journal of Industries* 1925, respectively. This fact, however, only affords one more illustration of the difficulty of writing any book on a technical subject which shall not be, in some respects at any rate, out-of-date before it issues from the press.

Board of Education. Catalogue of the Collections in the Science Museum, South Kensington; with Descriptive and Historical Notes and Illustrations. (1) Water Transport. 2: Steam Ships of War. Compiled by G. L. Overton. Pp. 102 + 8 plates. (2) Land Transport. 2: Mechanical Road Vehicles. Compiled by E. A. Forward. Pp. 87 + 10 plates (London: H.M. Stationery Office, 1925.) 1s. net each.

(1) THERE are four considerable collections of warship models in London, those at the Imperial War Museum, at Greenwich, at the Science Museum, and at the Royal United Service Institution. The largest and most important is, however, that at the Science Museum. This collection had its birth when the Admiralty in 1864 sent to South Kensington a number of models for the use of the students of the Royal School of Naval Architecture, for though most of these were afterwards transferred to the Royal Naval College, Greenwich, a nucleus remained, and this has been developed from time to time. Of the sailing men-of-war, a catalogue

was issued a year ago, and the catalogue of the steam men-of-war deals with the second part of the naval collections. Compiled by Mr. G. L. Overton, the catalogue shows signs of great care; its illustrations are good, while the historical notes, though brief, are excellent summaries of the progress of warship evolution down to the *Hood*.

(2) The second catalogue under notice deals with the second group of the Land Transport Section of the Museum—mechanical road vehicles. We here meet with the steam carriages of Cugnot, Murdoch, Trevithick, Gurney, and others, as well as the petrol cars of Benz, Panhard, Daimler, and Rolls-Royce. The motor section often has up-to-date bicycles, engines, etc., on loan, but these do not appear in the catalogue. Many of the early historic petrol cars in the possession of the Museum are still stored in the basement.

Biochemistry: a Laboratory Course for Medical Students.

By I. Frost. Pp. ii+56. (Madras: Government Press, 1924.) Not for sale.

THE multiplication of manuals dealing with practical biochemistry for medical students appears to be an expression of the differences existing between the courses in this subject in the various schools. Each teacher selects from the large number of possible exercises those which both fulfil the requirements of the examination his students must pass and at the same time appear to him most suitable. Each school thus tends to develop its own course in biochemistry, with the result that a course which reaches publication as a small manual may fail to meet the requirements of other schools, which are, however, induced by its appearance to publish their own course.

The manual before us appears to us to strike a distinctly original note; Dr. Frost has apparently kept in mind the fact that biochemical investigations nowadays come to the aid of the clinician, and that an acquaintance with the methods used in the laboratory is essential for a true evaluation of the results of these investigations in relation to the clinical findings. The book opens with some experiments on colloids, together with examples of the colorimetric estimation of the hydrogen ion concentration of solutions: the proteins and blood pigments are only briefly treated, but a selection of the modern methods used in the examination of the blood and urine is given, each method being fully described.

We have noted a few misprints, especially on p. 24, where some decimal points have gone astray. Our impression is that the book sets a high standard in biochemistry for the medical student who is not reading for a science degree also.

An Introduction to the Strowger System of Automatic Telephony. By H. H. Harrison. Pp. vii+146. (London: Longmans, Green and Co., 1924.) 7s. 6d. net.

It is not very generally known that the engineers of the British Post Office have begun to change the telephone system of London into a fully automatic one. The task is enormous and it will be fifteen years before it is completed. During part of this time the system will be partly manual and partly automatic, but satisfactory arrangements have now been made so that

this will cause no inconvenience. This book is therefore very timely. It deals exclusively with the Strowger system, which is the one adopted by the Post Office. In this system there is a dial with 10 finger-holes punched in it. If a subscriber wants to call up Gerrard 8830 for example, he has to perform seven operations. He first puts his finger in the digit-hole with a G in it and moves it round to the stop and lets it go. He then repeats the operation with E and R the second and third letters in Gerrard; this connects him to the exchange. He then performs the same operation in the digit-holes marked 8-8-3-0 respectively. This calls up the subscribers. If the line is engaged the usual engaged signal is heard. The causes of delay at present are mainly due to indistinct articulation and to congestion of traffic during the "busy hour." Automatic telephony eliminates the former hindrance and diminishes the latter. As the change-over is effected, the number of telephone girls will be gradually diminished, the exchanges being entirely automatic, but the number of engineers and workmen required will be increased. This book will make a good text-book for class instruction on automatic telephony.

Switchgear for Electric Power Control. By E. Basil Wedmore and Henry Trencham. Pp. xii+335. (London: Oxford University Press, 1924.) 25s. net.

THE electric power engineer will find much in this book that will be of value to him. As electrical stations increase in size, the amount and the cost of the requisite switchgear increase very rapidly. Devices are required for protecting the machines and for protecting the distributing mains. The question often arises whether it is worth while to instal a very expensive protection device in order to protect a main, thus paying a heavy annual insurance, or to run the small risk of having the main broken down. Cable manufacturers naturally favour the latter alternative, whilst manufacturers of protective switchgear favour the former. The authors rightly point out that the psychological device of calling a piece of apparatus a "lightning arrester" alone ensures a market for it, even without the accompaniment of a "publicity campaign." Many English engineers have had the temerity not to use them. It has to be remembered, however, that in Great Britain we rarely have severe thunderstorms. The British Electrical and Allied Industries Research Association is carrying out valuable researches on switchgear, and Mr. Wedmore's official work keeps him in close touch with the most modern developments. The book discusses the latest practice.

Elements of Statistics. By Prof. F. C. Kent. Pp. xi+178. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 10s. net.

Is it possible to present the elements of statistics in an intelligible form to students almost devoid of mathematical training? The present volume professes to accomplish this, but it does so, if at all, only by an enormous restriction of the scope and depth of the subject. Mere tabulation and pictorial representation of statistics will not in themselves suffice in general unless accompanied by a searching scrutiny of the data,

not merely by applying formulæ to them but also in the light of the principles of the theory of error and of correlation. In the present volume, when a formula is required, it is usually either quoted without proof and used for numerical computation or deduced from one already quoted; but surely the results of such a computation can be appreciated only when examined in relation to the basic assumptions made in deducing the formula. Within the narrow limitations the author has imposed upon himself, the treatment is good and the exposition clear. The book is excellently produced.

Pathologie du sympathique: Essai d'anatomo-physiopathologie clinique. Par Prof. Maxime Laignel-Lavastine. Pp. v + 1080. (Paris: Félix Alcan, 1924.) 90 francs.

THIS volume is an exhaustive thesis dealing with the anatomy, physiology, and clinical aspects of the sympathetic system. Few details are omitted from this ponderous work; indeed, the fault lies in the enthusiasm which tends to implicate the sympathetic system in many conditions of obscure origin. Thus few will agree with the author in associating glaucoma, purpura, and osteodystrophies with sympathetic disturbances. In many instances the evidence in favour of autonomic nervous origin is not sufficiently dealt with; for example, in the section concerning gastric crises in tabes, the rôle played by the vagus is briefly dismissed, and the possibility of "vagal crises" as an entity is not mentioned. It is a pity that such an exhaustive work should have just preceded the valuable contributions of Hunter and Royle; their work on the sympathetic innervation of striped muscle and on treatment by ramisectomy is of course not included. The volume concludes with a very full bibliography.

Les edifices physico-chimiques. Par Dr. Achalme. Tome 3: La molécule minérale. Pp. 350. (Paris: Payot et Cie, 1924.) 20 francs.

THE principal feature of this book is a series of elaborate diagrams, first of the structure of *atoms*, which are represented as aggregates of spheres of various patterns, and then of *molecules*, which are represented as aggregates of these aggregates. The author has thus succeeded in building up a very elaborate series of molecular models; but as the details of these are purely speculative, they are not of any value as an aid to the study of chemistry. On the contrary, the author's system appears to call for a draughtsman to express even the simplest formulæ, and equations which can be written down in a few seconds in ordinary symbols become as complicated as the design of a new pattern for a carpet. It is difficult to see what can follow from such a system except to create a mistaken impression of the complexity of chemical science.

Organisation of Vocational Guidance: a Companion Volume to Administration of Vocational Education. By Arthur F. Payne. Pp. xvi + 438. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 17s. 6d. net.

ALTHOUGH the subject of vocational guidance is as yet in the experimental stage, the literature connected with some of its many aspects is increasing at a very rapid rate—evidence at least of a fairly general interest in it.

This book gives a survey of the chief work done up to the present time and is intended to be of use to all those responsible for advising people about their work in life, and for managers in stores, factories, and workshops. It discusses the various systems of testing intelligence and special aptitudes, normal and abnormal behaviour, physical stigmata, job analysis, as well as the organisation of a vocational guidance bureau. There is a useful bibliography and a large number of charts; it will be a valuable book of reference.

School Geography: a Critical Survey of Present Day Teaching Methods. By E. J. G. Bradford. Pp. 104. (London: Ernest Benn, Ltd., 1925.) 7s. 6d. net.

GEOGRAPHY as taught in schools at the present day shows great advances compared with a generation ago, but Mr. Bradford concludes from a wide experience of teachers and teaching that the tendency is to lay too excessive stress on causal connexions. This results in incoherence and a failure of the pupils to visualise world conditions. While deprecating any return to the mere iteration of facts which of old was the whole content of the subject, he pleads for the need of dwelling on other than causal relationships, especially more insistence on location and quantity. In short, he wants to give more precision and coherence to school geography, and this he believes would increase its educational value. The book is a thoughtful contribution to a difficult problem.

Low Temperature Distillation: Home Oil Supply and the Utilisation of "Waste" Coal. By Sydney H. North and J. B. Garbe. (The Specialists' Series.) Pp. vii + 216. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 15s. net.

THE authors give a reasoned and critical account of the various processes used in the low-temperature distillation of coal. The problem is one of very great importance, and although authorities differ in their estimates of the usefulness and economics of the method, it is certain to attract an increasing share of attention. The present volume may be welcomed as a useful contribution to the literature of the subject. It is well illustrated.

Agitating, Stirring and Kneading Machinery. By Hartland Seymour. (Chemical Engineering Library: Second Series.) Pp. 139. (London: Ernest Benn, Ltd., 1925.) 6s. net.

THE various types of machinery used for mixing liquids and solids are described, but theory has been omitted, "in the belief that this method of treatment will be of more service to the practical chemical engineer." A little theory would perhaps have been found interesting by the general scientific reader, who must feel that the book lies outside his province. It should be useful to those to whom it is addressed, and is well illustrated.

ERRATUM.—By a most regrettable oversight, the notice of the volume "The Atmosphere and its Story," by Ernest Frith, and that of "Why the Weather?" by Dr. Charles Franklin Brooks, were transposed. That appearing in NATURE of August 8, p. 204, refers to Dr. Brooks' book, while the notice in the issue of August 15, p. 241, should have appeared under the bibliographic details of Mr. Frith's book.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Nature of Radiation.

BOTHE and Geiger have recently performed an experiment on the Compton effect (*Die Naturwissenschaften*, 13, p. 440, May 15, 1925; *Zs. f. Phys.*, 32, p. 639, 1925) indicating that the recoil electron, and the photoelectron emitted by the scattered radiation, appear simultaneously. Prof. A. H. Compton has made another experiment (*Proc. Nat. Acad. Sci.*, 11, p. 303, 1925), showing that the direction in which the scattered radiation acts in producing ionisation, and the direction of the recoil electron, are related. The natural interpretation of these experiments is in terms of a corpuscular theory of radiation, in which a corpuscular quantum, glancing off a scattering atom with emission of a recoil electron, very soon hits another atom and emits a photoelectron. This contradicts the suggestion, discussed by Bohr, Kramers, and the writer (*Phil. Mag.*, 47, p. 785, 1924), that there was a virtual field, like the ordinary fields of optical theory, emitted during the stationary states of the atom, the function of which was to induce a probability of transition; for on that view the probabilities of ejection of electrons by the scattering and absorbing atoms would be independent, both being induced by a radiation field existing continuously, and the two electrons would be in general ejected at different times and in unrelated directions. I wish to point out, however, that a corpuscular theory still is not in conflict with the main part of the idea of virtual fields.

The possibility of harmony between a virtual radiation field and a corpuscular structure of light was discussed with great penetration by Prof. Swann, in his address at the meeting of the American Association for the Advancement of Science last Christmas (*Science*, 61, p. 425, 1925). Prof. Swann suggested the existence of a field, obeying Maxwell's equations, the function of which should be to guide corpuscular quanta, which might travel along Poynting's vector. This was also the idea on which the writer was working when he first considered a field emitted during the stationary states, although Prof. Swann was not aware of this. (*NATURE*, 113, p. 307, 1924; *Phys. Rev.*, 25, p. 397, 1925)

The theory in this form was developed in England, under the guidance of Mr. R. H. Fowler, to whom my sincerest thanks are due. The essential feature was the emission of the field before the ejection of the corpuscle; that is, during the stationary state before the transition. By this device were avoided the difficulties of explaining coherence, of the "size of quanta," of the presence of interference phenomena in weak light. When this view was presented to Prof. Bohr and Dr. Kramers, they pointed out that the advantages of this essential feature would be kept, although rejecting the corpuscular theory, by using the field to induce a probability of transition rather than by guiding corpuscular quanta. On reflection, it appeared that no phenomena at that time known demanded the existence of corpuscles. Under their suggestion, I became persuaded that the simplicity of mechanism obtained by rejecting a corpuscular theory more than made up for the loss involved in discarding conservation of energy and rational causation, and the paper already quoted was

written. The changes made in adopting this view were thus not fundamental; it might be mentioned that they were not new, the failure of conservation having been suggested by D. L. Webster and others, and the idea of a field to induce a probability of transition being due to Jeans.

The present experiments, however, seem to show definitely the characteristic properties of corpuscles: the localisation of the active power of a light wave in space (Compton) and in time (Bothe and Geiger), although of course the evidence is as yet meagre. The simplest solution of the radiation problem then seems to be to return to the view of a virtual field to guide corpuscular quanta. One slight difficulty in the way of carrying this out should be mentioned: the velocity of a corpuscle should transform under the Lorentz transformation as a velocity, and Poynting's vector does not so transform. There are other difficulties as well, but one may hope that none of them are insurmountable.

It seems to me of particular value to realise that the facts of optics are, in general, satisfactorily described by theories of the electromagnetic field; that it is highly improbable that any essentially different theory could also explain such an extended set of facts; and that consequently we must expect to find this theory appearing in some form or other in our final description of radiation, whatever that may be, and whether it include corpuscular quanta or not. Some physicists have been tempted to throw away the great work of Maxwell and Lorentz, because there are phenomena which suggest light corpuscles. This seems to me a very doubtful policy; for a corpuscular theory of the kind now indicated would by no means take the place of the electromagnetic theory, but would rather supplement and extend it. Some of the material for this extension must naturally come from such experiments as those of Bothe and Geiger and of Compton.

J. C. SLATER.
Jefferson Physical Laboratory,
Harvard University,
July 25.

The Effect of Diluents on the Initial Stages of Catalytic Action.

It has been long known that the presence of diluent vapours in the reactants depresses the reaction velocity at a catalyst surface. The following quantitative treatment has been confirmed by experiments on the effect of water vapour on the initial stages of the dehydrogenation of alcohol by copper. Let p = the fractional partial pressure of the reactant A , hence $1 - p$ = the fractional partial pressure of the diluent B . Then the rate at which the reactant molecules arrive at the surface is proportional to $p/\sqrt{2\pi MRT} = \mu_A p$, say. Thus the probability that a reactant molecule should bombard a given portion of a catalyst at a given instant is

$$\frac{\mu_A p}{\mu_A p + \mu_B(1 - p)},$$

i.e. the fraction of A molecules in the impinging stream of A and B molecules. According to the conception of Langmuir and Frenkel, a molecule that hits another adsorbed molecule is immediately reflected, whereas when it strikes the bare surface it remains for the short period of time τ . It is also known that chemical action occurs on definite centres on the catalyst surface.

Let n be the number of times one of these centres becomes momentarily vacant in t units of time, then $\mu_A \cdot p \cdot n / \{\mu_A p + \mu_B(1 - p)\}$ molecules of the reactant are adsorbed, and they occupy the portion of activity for a fraction of the total time $= \mu_A \tau \cdot p n / \{\mu_A p + \mu_B(1 - p)\}$.

Similarly for species *B*. If the surface is saturated, the time during which a centre is left vacant is negligible compared with the time it is covered, and

$$t = \frac{\mu_A \tau_A \phi n + \mu_B \tau_B (1 - \phi) n}{\mu_A \phi + \mu_B (1 - \phi)}$$

Thus the fraction of the total time the centre of activity is occupied by the reactant is

$$\frac{\mu_A \tau_A \phi}{\mu_B \tau_B (1 - \phi) + \mu_A \tau_A \phi} = v,$$

and is the fractional reduction in the reaction velocity. Thus

$$1/v = (1 - \lambda) + \lambda/\phi, \quad (1)$$

where $\lambda = \sqrt{\frac{M_A}{M_B}} \cdot \frac{\tau_B}{\tau_A}$ and M_A represents the molecular weight, and τ_A the mean life of the molecule *A* on the surface. This formula may be written

$$(1 - v)/v = \frac{\tau_B}{\tau_A} \cdot \frac{\mu_B (1 - \phi)}{\mu_A \phi},$$

and the fraction $(1 - v)/v$ is the ratio of the number of molecules of *B* to the number of molecules of *A* present on the surface. $\mu_B (1 - \phi)/\mu_A \phi$ is the ratio of the number of molecules of *B* to *A* bombarding the surface $= n_B/n_A$. Thus if n_B/n_A be multiplied by the ratio of the mean lives of molecules *B* to *A* on the surface, we obtain the composition of the adsorbed gas film for saturated surfaces. The composition of the adsorbed gas film in equilibrium with a mixture of gases *A* and *B* is given by

$$\frac{x_A}{x_A + x_B} = \frac{1}{1 + \sqrt{\frac{M_A}{M_B}} \cdot \frac{\tau_B}{\tau_A} \cdot \frac{p_B}{p_A}} \quad (2)$$

These formulæ have been verified for partial pressures of alcohol in water varying from 0.02 to 1.00 times the total pressure.

Fractional Reaction Velocity observed. v .	Calculated from $[1/v = 0.64 + 0.36/p]$.	Fractional partial Pressure of Alcohol in Alcohol Water Mixtures $= p$.
1.00	1.00	1.00
0.94	0.92	0.80
0.83	0.81	0.60
0.60	0.65	0.40
0.40	0.41	0.20
0.22	0.24	0.10
0.10	0.13	0.05
0.05	0.05	0.02

The agreement between the observed and calculated values is within the limits of experimental error.

The apparatus with which these measurements were made has already been described (Proc. Camb. Phil. Soc., vol. 22, pp. 738-50) and is very convenient for obtaining the wide variations in partial pressure necessary.

F. H. CONSTABLE.

St. John's College,
Cambridge, July 30.

On the Origin of Species in Flowering Plants.

THE origin of species is the origin of the difference between two species. The existence of a peculiar difference between good species, which does not exist between varieties, has long been realised by systematists and others. This essential difference expresses itself, in part, in flowering plants, in the abortion of pollen and ovules in the hybrids, which

springs, in typical cases: (a) from a different distribution of genes between two or more chromosome pairs; so that vital genes are omitted after the reduction division in some or all of the groups of chromosomes of the F_1 of the cross. An example of this is probably afforded by the crosses of certain species of *Stizolobium* (*Mucuna*) (*Zeitsch. f. ind. Abst. u. Vererb.*, pp. 303-342, 1914), two non-homologous chromosomes appearing to have interchanged genes in one of the species. In the second case (b) the attraction between chromosomes which should be homologous fails in the reduction divisions of the F_1 plant, so that non-conjunction (*Journal of Genetics*, 1925) takes place with regard to one or more pairs. Thus there is an absence of vital chromosomes or the presence of extra chromosomes in some of the pollen and ovules. This is illustrated by the two cannas "Austria" and "Italia," which belong no doubt, as their history states, to the F_1 of species crosses. In "Austria," for example, the 18 single chromosomes show only 1-3 pairs at the reduction divisions. All the other chromosomes segregate at random, so that no more than one pollen-grain or embryo-sac out of thousands contains only the 9 chromosomes from one parent, and survives. In the cross of radish and cabbage, as Karpechenko (*Journal of Genetics*, vol. 14, pp. 375-396, 1924) has lately shown, chromosome conjugation is absent. This has also been shown in certain *Digitalis* crosses.

Hence the origin of species is effected, *inter alia*, by (a) segmental interchange between non-homologous chromosomes, of which some evidence has lately been gathered in *Datura*, and (b) by the loss of attraction between chromosomes which were homologous, producing non-conjunction (*Journal of Genetics*, 1925). The hypothesis of the origin of species from crosses between species in a genus posits the existence of allied species, and can thus only be applicable in more or less exceptional cases.

The species listed, in any genus may consist of forms each showing one or more of the following differences from the nearest allied species:

(1) Mendelian differences in one or more pairs of genes;

(2) Mendelian or other differences permanently sustained by propagation by apogamy;

(3) Shifting of some genes in one species between two or more non-homologous chromosomes;

(4) Loss of mutual attraction between two or more corresponding chromosomes in the two species;

(5) Different chromosome numbers or sizes.

Of course the mere possibility or impossibility of securing an F_1 between two species may often be due to other more superficial causes than these fundamental differences.

JOHN BELLING.

Carnegie Institution of Washington.

The Structure of Benzene and Cyclohexane and their Optical Anisotropy.

IN a recent paper (Roy. Soc. Proc., A, vol. 107, p. 684), I have shown that the optical anisotropy of the gaseous molecules of a number of di-atomic and tri-atomic compounds which is evidenced by the polarisation of the light scattered from them, can be explained by the mutual action of the electrical doublets induced in the different atoms of the molecule by the electric field of the incident radiation. Each atom was assumed to behave isotropically. Satisfactory agreement was obtained between the observed and calculated values of the depolarisation of the scattered light in the case of the molecules CO_2 , N_2O and CS_2 .

The investigation has now been extended to the organic molecules benzene and cyclohexane. Experiment shows that the depolarisation (*i.e.* the ratio of the weak component to the strong) of the light scattered in a direction perpendicular to the incident beam in benzene vapour is 0.067. Assuming that the six carbon atoms in benzene are arranged in a puckered ring as in diamond, with the distance between two neighbouring carbon atoms of 1.5 Å.U., and that the hydrogen atoms are joined to the carbons at the tetrahedral angle at a distance of 1.42 Å.U. (the sum of the "radius" of a carbon atom and half the distance between the optical centres in a hydrogen molecule as calculated from its optical anisotropy), and assuming that the refractivities of the hydrogen and carbon atoms are those appropriate to the respective atoms in the hydrogen molecule and in diamond, the anisotropy comes out to be 2.63:2.63:1. This gives a value of 0.074 for the depolarisation of the transversely scattered light.

If the atoms are assumed to lie in a plane with the carbon atoms arranged as in a graphite ring, the depolarisation comes out to be 0.10. Even in the absence of the hydrogens, the six carbon atoms alone would in this case give rise to a depolarisation of 0.083. If, therefore, we are to retain the plane structure for benzene, it will be necessary to assume that the polarisation of the carbon atoms when the field is perpendicular to the plane of the ring is greater than that when it is parallel to the plane of the ring.

Cyclohexane vapour at pressures less than one atmosphere shows a depolarisation of only 1.1 per cent. This small value is what should be expected from the known structure of cyclohexane. The six extra hydrogen atoms place themselves on opposite sides of the mean plane of the carbon atoms on either side alternately, and the mutual action of the induced doublets causes the average polarisation parallel to the mean plane of the carbon atoms to be diminished while the polarisation perpendicular to the plane is increased, both contributing to a diminution of anisotropy. Calculation on the same lines shows the depolarisation to be expected to be 0.8 per cent.

K. R. RAMANATHAN.

Physics Department,
University College, Rangoon,
July 18.

Magnetic Conditions in Tube Railways.

THOSE who have occasion to make frequent use of the tube railways in London can minimise the monotony of such journeys by taking with them a small pocket compass.

Using one day a pocket compass to determine whether my hurried choice of a train was indeed taking me in the westerly direction I desired, I was astounded to find that this old and valued guide was of two minds, if no more, as to where magnetic north really lay. As the train proceeded, the compass needle oscillated, made a sudden 180° turn and pointed south, and in a few moments reversed its direction again.

Repeated observations show the needle to be scarcely ever steady, and this makes it difficult to distinguish the acceleration effect which must be present: such accelerations when nearly at right angles to the magnetic meridian should produce an angular motion of the needle equal to the angle of change of the "apparent vertical" multiplied by the tangent of the angle of dip. I have noticed motions

of the right sense and of about the right amount, but it has not been possible to compare the amount of the accelerations so indicated with those determined by other methods.

I do not know whether any one else has noticed the complex magnetic condition of tube railways, but I do know that any visitor who relies for directional advice upon a pocket compass may be led sadly astray.

H. E. WIMPERIS.

August 4.

Fine Structure of Optically Excited Spectrum Lines.

IN the course of investigations on the optical excitation of gases in this laboratory, we noticed the interesting fact that the spectrum lines emitted by mercury vapour illuminated by an intense mercury lamp have a much simpler fine structure than usually. For example, the green line 5461, the complexity of which under ordinary conditions is well known, presents no components besides the central line, which when viewed through a 30 cm. Lummer plate, is resolved in 3 components only. The violet line 4359 exhibits the same features, the intensity of the stronger satellites as compared with that of the central line being very much less than in the arc. The same seems also to be true for the yellow line 5770. On the other hand, the lines 4047 and 5791 show all the strong satellites.

This absence of some of the satellites which are intense in the arc affords an argument in favour of the view that these are not due to isotopy.

E. GROSS.

A. TERENIN.

Optical Institute,
Leningrad,
June.

Science and Intellectual Freedom.

DR. NORMAN R. CAMPBELL (*NATURE*, August 8, p. 208) writes with a certain lack of charity about the numerous men of science, medical men, publicists, and so forth, who have ventured to inform themselves about birth control. To seek knowledge about the origin of species, he informs us, may be honest and honourable, but "knowledge concerning contraception is sought, either from mere prurience, or from intention to practise it or to teach others to do so." But that is just what a Tennessee Fundamentalist would say about interest in evolution. He would say men wanted to know they were beasts in order to make beasts of themselves. It is impossible to let Dr. Campbell's sweeping indictment pass unchallenged. People in general want to know about this matter in order to judge it; they want to know the nature, the naturalness, the physical good or evil of these practices and what the mental and social reactions of this or that line of action may be. It is no more "prurient" to be intelligently interested in the question than in dietary. No one wants the publicly paid medical man to "propagate" this knowledge where it is not desired. But we do want to see him free to give it, cleanly and discreetly, to people who know already that it exists and who will, failing him, probably seek it in shameful and dangerous ways. We object to any sect or section of the community coming with threats of dismissal and injury between him and those who want to know. That is what is done at the present time. And while this is the case in Britain I decline to line up to sneer at the Fundamentalists of Tennessee.

H. G. WELLS.

The Theory of Photographic Sensitivity.

By DR. T. SLATER PRICE, F.R.S., and S. O. RAWLING.

SINCE 1920 our knowledge of the formation of the latent image has been greatly increased by investigations which divide themselves roughly into three chapters. The first notable advance was made by Svedberg during the years 1920-1922, and consisted in the proof that the latent image consists of small centres distributed on the silver halide grains of an exposed photographic plate, the distribution of the centres being entirely according to the law of chance. A grain is not developable unless it contains at least one such centre. The second step was to decide upon the origin of these development centres. Two theories were advanced. In one of these it was assumed that the light itself formed the centres, the grains themselves being supposed to be homogeneous. In the other, it was assumed that there exist in the grains, prior to exposure, nuclei which are not silver halide and which are formed during the manufacture of the emulsion, and that the action of light is to change their condition in such a way that they become centres at which development can start. The first theory was extensively investigated and modified by Silberstein and others in the Research Laboratories of the Eastman Kodak Company, whilst the second was developed by Toy in the laboratories of the British Photographic Research Association. Direct evidence in favour of the second theory was at length obtained by Clark in the latter-named laboratories.

The third advance has recently been concisely summarised by Sheppard (*Jour. Franklin Inst.*, 1925, 200, 51), and deals with the nature of the nuclei postulated in the second theory mentioned above. If the nuclei are light sensitive, and are essentially different from silver bromide, their spectral absorptions should determine the spectral sensitivity of the material, or, at any rate, powerfully affect it. The relative spectral sensitivity of plates before and after desensitising with chromic acid is found to be the same, however, and the distribution of sensitivity corresponds approximately with the absorption spectrum of gelatino-silver bromide (Sheppard, Wightmann, and Trivelli, *Jour. Franklin Inst.*, 1923, 196, 653). Moreover, the experimental relation between the quantity of the incident light energy and the photographic effect produced is just what is to be expected when allowance is made for the light absorption of the silver bromide, the agreement being all the better when the light absorbed is reckoned in quanta (Toy and Edgerton, *Phil. Mag.*, 1924, 48, 947).

As a result of the consideration of the above facts, the following theory of the nature of the nuclei has been arrived at. It is assumed that the action of light is to decompose the silver bromide into bromine and silver, and that the apparent sensitising action of a nucleus or "speck" is confined to increasing its size by accretion of photochemically reduced silver atoms until it is large enough to form a development centre. The mechanism by which this accretion is supposed to be brought about is, apparently, that light is absorbed all over the grain and that the energy of vibration of

the electrons in the atoms of the silver halide crystal is thereby increased; but, as a rule, the transfer of an electron from bromine to silver only occurs in the boundary layer at the surface of the specks. Thus energy flows from the surrounding crystal lattice to the specks where it is released as chemical work, the transfer from distant atoms occurring by radiationless collisions (vibrations) through neighbouring atoms until the edge of the speck is reached. It may be noted that Toy (*Phot. Jour.*, 1921, 61, 420) ascribed to Slade a somewhat similar idea as to the transference of energy within the crystal; at that time, however, the attempt was made to explain on this basis how development centres might be formed by light action without the aid of sensitising specks, the mechanism of the action being a kind of "surging" of energy within the crystal and the consequent formation of development centres where energy sufficient to bring about the necessary chemical decomposition is momentarily concentrated. The new theory may thus be considered to be an extension of Slade's original idea to that of the existence of sensitising specks.

According to Sheppard, the formation of the specks is due to casual adsorption and reaction with the silver bromide of a substance present in the gelatin. The theory given leads to the conclusion that once a speck is formed it tends to increase in size; further, not only will the average number of specks on large grains tend to be greater than on small ones in the same emulsion, but also the average size of speck will be greater. It further follows that the sensitising power of any speck is a function of its size. A large speck would not require so large an amount of chemical decomposition in its neighbourhood as would be required by a small speck in order to make a development centre. Svedberg had already touched on the idea that a certain minimum size of speck is necessary before it can act as a development centre, and Clark had deduced that it must be such that it contains somewhere about 300 atoms of silver.

The theory of the distribution of the specks is therefore in striking agreement with the conclusion arrived at by Toy in 1922 (*Phil. Mag.*, 1922, 44, 368) that there are two reasons why large grains are, on the average, more sensitive than small ones. First, there are more nuclei (specks) present in the larger grains, so that a single grain has a greater chance of having at least one; and secondly, the average sensitivity of the nuclei increases with the size of grain.

There is a third factor which may possibly assist in making large grains more sensitive than small ones. Specks on large grains have a greater volume of silver halide from which the absorbed energy necessary to produce the photographic effect may be drawn.

The investigations which led up to the point marked by the theories outlined above furnish no direct evidence of the chemical nature of the specks. Rapid advances were being made in various laboratories towards the solution of the problem, when a paper of Sheppard, from the Research Laboratories of the Eastman Kodak Company, appeared, in which it is

shown that silver sulphide is a substance which can act as a general sensitiser of the kind described. Sheppard (*Phot. Jour.*, 1925, 65, 380) directs attention to the well-known fact that some gelatins are photographically active, whilst others are relatively inert. Making use of the unrivalled facilities of such an organisation as that of the Eastman Kodak Company, which has its own gelatin manufactory, several thousand gallons of deliming liquor, which is formed in the manufacture of gelatin, and was found to be photographically active, were concentrated by appropriate treatment, active fractions being separated from time to time. Ultimately, after some years of investigation, the active substance was tracked down and identified as allyl isothiocyanate, or allyl mustard oil. In the course of manufacture of a photographic emulsion, this substance reacts with the silver halide grains to give the silver sulphide specks to which reference has been made above. It is estimated that photographically active gelatin contains only about 1 part per 1,000,000 to 1 part per 300,000 of the sensitising substance. Other sulphur compounds have been found to act in a similar manner, a necessary condition seeming to be that the sulphur must be doubly linked

to another atom, and not singly linked to two other atoms. The analogous compounds of selenium and tellurium act in a similar way.

The presence of a speck of silver sulphide in the silver halide crystal would result in a disorientation of the silver and halogen atoms at the common boundary, and consequently give rise to a region of instability in its neighbourhood, a view which is supported by the work of von Hevesey (*Z. physikal. Chemie*, 1922, 101, 337).

In all the work which has contributed to the achievement of the present position in regard to photographic sensitivity, it is remarkable how interwoven the ideas of various investigators have become. A mass of evidence from very different sources has now been accumulated in support of the theory that the high sensitivity of the modern photographic plate is due to the presence, before exposure, of minute traces or specks of some "impurity" on the surface of the silver halide grains in the emulsion. The work of Sheppard is a great step forward and opens up new avenues of research, but much work remains to be done before the problem of photographic sensitivity is finally solved.

Sino-Himalaya.¹

By F. KINGDON WARD.

THAT "Any Man's Land" where China, Tibet, and India meet has come into prominence amongst botanists in recent years by reason of the remarkable wealth of flora discovered there; and connected with the problems of plant distribution which arise is the no less interesting problem of geological structure and history. A brief description of the physiography of this region may serve to illustrate the nature of these problems.

We have as a starting-point the great Himalayan range and the mountainous area of western China. East of the 93rd meridian the Himalayan axis trends towards the north-east. It seems probable that this axis is prolonged across China, and that structurally it could be traced in that direction to the plains.

However, what the traveller, who is unable to follow the strike of the rocks composing a great mountain chain like the Himalaya, sees, is something rather different. He sees the Himalayan range ending abruptly at the gorge of the Tsangpo in the great peak of Namcha Barwa; and even if he recognises the peak of Gyala Peri, which forms with Namcha Barwa the gateway to the gorge, as being on the main Himalayan axis beyond the Tsangpo, he can follow it no farther, for the country is unexplored. From the Tsangpo gorge eastwards he perceives rather a wide breach in the Asiatic divide, beyond which in the complex skein of mountains which form a network over western China he is unable to pick up the dropped thread of the Himalayan axis, though the facts of both animal and plant distribution in eastern Asia point to its former, if not to its continued existence.

That this supposed breach in the Himalayan axis

does really exist seems clear enough; though whether at the eastern extremity or in the middle of the range is not so clear.

Rising on the plateau of Tibet are several great rivers whose sources are far apart and whose mouths ultimately open on different seas; but all of them, rolling down from the highlands, converge on one another, squeeze through a narrow gap flanked by lofty snow peaks, and separate again as they emerge from the mountains. In the west is the Brahmaputra (Tibetan Tsangpo), which, after rounding the great gable end of the Assam Himalaya, swings away to the west. In the extreme east is the Yangtze (Chinese Kin-sha), which, after squeezing through the breach, swings away to the east to cross China. Between them, but closer to the Yangtze than to the Brahmaputra, flow three other big rivers, the Mekong, Salween, and Taron (or eastern branch of the Irrawaddy).

The extreme breadth of this river gap is about 200 miles; but a much smaller distance—namely, 70 miles—will span the gap between the Yangtze and the Taron, including the gorges of the Mekong and Salween. That is to say, these four rivers, where they flow parallel to one another for a depth of about 100 miles, are confined to a strip only 70 miles wide. A further peculiarity about this strip is a pronounced tilt from east to west, whereby these rivers flow at successively lower and lower levels as we proceed westwards from the Yangtze to the Irrawaddy.

The reasons for this may be at least partly explicable on the theory of isostasy, the vast area of deposition towards the head of the Bay of Bengal being counterbalanced by a rise in the country to the east, which is essentially an area of denudation. Even the progressive lowering of the river beds might be due to a detailed isostatic equilibrium, being proportional to their

¹ Substance of two lectures delivered at the Royal Institution on April 3 and 30.

powers of erosion and capacity for deposition, according to the views of Colonel Tandy.²

That the grading of the river beds should follow mechanically from the proportionate rainfall in the gorges seems to us quite untenable. If we accept the view that a river is primarily erosive in action, then the Yangtze, with its much greater and more powerful stream and its larger volume of glacier water, should have cut out the deepest channel; but it has not. On the other hand, if we accept Colonel Tandy's view that a mountain river bed is primarily an area of deposition, then the Yangtze, which certainly receives a much greater dead-weight load from its arid cliffs than does the forested Taron, should still have sunk its bed lower. Moreover, the several source streams of the Irrawaddy show the same progressive decrease in altitude from east to west, though their respective volumes steadily decrease also; and here the rainfall is obviously constant for all.

We must not, however, lose sight of the fact that the breaching of the Himalayan axis was probably due in the first instance to tectonic causes, not to river action; and that therefore the parallel gorges owe their origin at least in part to tension, and follow lines of weakness in the crust. Here again the weight of material which the crust, immediately to the west, has to support, dragging on the folded rocks of the Burma-Yunnan arc to the east, may have cracked the synclines; for the Burma-Yunnan arc is probably of the same age as the main Himalayan uplift.

Prof. J. W. Gregory indeed refers to the Mekong, Yangtze, and other rivers of Chinese Tibet being formed as "tension clefts by the rupture of hard rocks which were pulled apart on the stretched upper side of an arch."³ However, I can deal here only with results, whatever the causes.

The south-west monsoon, blowing up from the Bay of Bengal, strikes against the south face of the Himalaya and drops the bulk of its moisture. Thus it crosses the line of high peaks a comparatively dry wind, and the plateau country behind the Himalaya is in consequence semi-desert.

The Burma-Assam re-entrant, however, forms a funnel-like approach to the Himalayan gap, and the monsoon rushes like a bore through the neck of the funnel and up the river corridors of the Tsangpo, Irrawaddy, and Salween; with the result that the region lying at the head of the gap, and partly behind the Himalaya, is also drenched with rain. Thus the breach, or gap, as we have called it, is the meeting ground of several floras. To the north is the Central Asian flora—more particularly the Tibetan element, pressing southwards through the gap; while to the south is the Indo-Malayan flora, squeezing northwards up the river corridors until it makes contact with the former. In the east is the Chinese or Oriental flora, while confined to the ranges which form a network over the whole area is the Alpine or Himalayan flora.

On the parallel ranges of the Burma-Yunnan arc is found a flora related on one hand to the Chinese flora generally, on the other to the Himalayan flora; and it would appear that these mountains, having received contributions from both the broken ends of the Sino-

Himalayan ranges, have carried this flora far to the south.

Nothing was previously known of the flora round the knee-bend of the Brahmaputra, however, and it was not until 1924 that, through the kind offices of the Indian and Tibetan governments, permission was granted for a botanical expedition, financed by the Royal Society and the Percy Sladen Memorial Fund.

One would naturally suppose that the alpine flora of the Assam Himalaya would more closely resemble that of the Sikkim-Bhutan Himalaya than it does that of the Burma-Yunnan arc; for while the Assam Himalaya stand about midway between Sikkim and Yunnan, the Himalaya form a continuous uplift from Sikkim to Namcha Barwa, whereas the Yunnan ranges are a separate uplift sundered from the Himalaya by several deep river gorges. Yet the reverse was found to be the case.

If we examine the more prolific genera, such as *Rhododendron*, *Primula*, and *Meconopsis*, we find groups common to the Assam Himalaya and to Yunnan which have no representatives in Sikkim. To take a few examples. There exist a group of creeping *Rhododendrons* of the 'Sanguineum' series, previously known only from Yunnan and Burma, now recorded from the Himalaya; they do not extend so far west as Sikkim. Similarly with the undershrub *Rhododendrons* belonging to the 'Saluenense' and 'Campylogynum' series.

Coming next to *Primula*, the section known as 'Sikkimensis' has representatives both in Sikkim and in western China, but hitherto no purple-flowered species was known to occur west of the Mekong; yet such purple-flowered species are abundant in the Assam Himalaya and to the north. Again, the queer *Primulas* which fall into the section 'Maximowiczii' have hitherto been regarded as confined to western China; but two species, possibly identical with the Chinese types, have now turned up in the Assam Himalaya.

Two species of the section 'Dryadifolia,' one of them *P. dryadifolia* itself, hitherto known only from Yunnan, are now definitely recorded as Himalayan, while the 'Nivalis' section, so richly represented in China and so poorly in Sikkim, obtains additional support as a Himalayan group in half-a-dozen species from Namcha Barwa.

In the genus *Meconopsis* we find exactly the same thing—a closer association with Yunnan than with Sikkim. Amongst the 'Grandes,' for example, we find in the Assam Himalaya two yellow-flowered poppies almost exactly like the Chinese *M. integrifolia* and its so-called variety *M. integrifolia* var. *Souliei*; while a species closely allied to *M. impedita* is abundant. The only Sikkim species met with were such as are common to Tibet or to the Himalaya generally, e.g. *M. simplicifolia* and *M. horridula*.

One could multiply examples, but enough has been said to bring out the Sino-Himalayan relationship. I have selected these genera as being those with which, from a horticultural point of view, I am best acquainted; but I believe that when the whole collection has been worked out, this unexpected relationship will be more strongly emphasised. There is also, of course, a considerable endemic flora.

From this it would seem that not only is the present breach between the Himalaya and the Burma-Yunnan

² *Geographical Journal*, May 1921.

³ *Geographical Journal*, March 1923.

arc recent, but that the linking-up of the Assam and Sikkim Himalaya is also recent; otherwise their floras should more closely resemble one another, since they are under almost identical conditions.

The most striking feature of the country immediately to the north of the Tsangpo bend is the number of ice-worn valleys and the extent to which deglaciation has gone on and, judging by the retreating glaciers, is still going on. The Tsangpo valley above the gorge seems to have been in part at least formed by ice action. At all events it is certain that the glaciers of Namcha Barwa once crossed the present valley, since one sees huge amounts of moraine material, continuous with "living" moraines on the right bank, piled up on the north bank, and afterwards cut through and stranded, terrace on terrace, by the river. The gorge itself, however, is clearly due to water erosion, though at one point a glacier does actually reach the river bed from the north bank. This retreat of the ice must be due to gradual desiccation rather than to a general increase of temperature, since lakes are also drying up, and these would scarcely be affected by a small rise of temperature. This ice action is far more conspicuous in the Assam Himalaya and on the ranges to the north of the Tsangpo bend than in other regions we visited;

and it might be that the elevation of the Assam Himalaya is of more recent origin than that of the Himalaya as a whole. If, as Sir Sidney Burrard⁴ has suggested, the Tsangpo originally flowed from east to west, then there must have been much less accumulation of silt in the Assam valley formerly than there is now, with the result that there would be less "compensation" needed. The cutting through of the Himalayan axis by the Dihang and the "capture" of the Tsangpo would soon alter this, and the Assam Himalaya might have been considerably raised as a result. But with the rise of this great rain screen, the doom of the glaciers to the north was also sealed. The removal of this enormous weight of ice, and the consequent transport of a huge amount of abraded material by water to the Bay of Bengal, would still further have loaded the crust in that direction and released it in the Himalayan area.

The numerous considerable falls in the Tsangpo gorge and the steep grade of the bed suggest that this river is much newer than the Salween or the Mekong. Thus the Assam Himalaya might be regarded rather as an outlier of the Burma-Yunnan arc, severed from it by the cutting back of the Brahmaputra (or Dihang), and still bearing a very close resemblance to it in its flora.

⁴ "A Sketch of the Geography and Geology of the Himalaya and Tibet."

Science and Intellectual Freedom.

By WATSON DAVIS and Dr. FRANK THONE, Science Service, Washington, D.C.

AMERICAN men of science naturally felt considerable interest in the trial of John T. Scopes, high school teacher, at Dayton, Tennessee, for the alleged violation of the now famous anti-evolution act on the statute books of that State. Relatively few scientists in this country are directly threatened by the epidemic of anti-evolution legislation; for this is at present confined largely to the southern States, and the majority of the more important colleges and universities, both independent and State-supported, are in the north and west. However, interest in the continued academic independence of their colleagues in the south brought a number of scientists to Dayton as scientific coadjutors for the defence counsel, while many more had signified their willingness to attend if called upon. They would have appeared as expert witnesses also, had the judge not ruled against the admissibility of scientific testimony.

Certain aspects about the outcome of the case may possibly need a word of explanation to those unfamiliar with American law procedure and with the somewhat peculiar circumstances of this particular trial. The defence did not attempt to prove that their client, Mr. Scopes, had not violated the statute as interpreted by the court. They stated that they intended to prove that the law was contrary to the constitution of the State of Tennessee and to the constitution of the United States, and that it was so vague and unscientific in its structure as to be meaningless. For this reason they wished to introduce scientific testimony; and when the court ruled that such testimony was irrelevant, the ground was cut from under their feet. It was conjectured, however, with a good deal of probability, that two or three men on the jury, irritated over the conduct of the case, were prepared to "hang the jury" and prevent the unanimous

verdict necessary to convict. The counsel for the defence wished to prevent such an outcome, for then the case would have had to be tried all over again before another jury, with the outcome just as unpredictable as it was the first time. Therefore we were treated to the unprecedented spectacle of the chief counsel for the defence virtually appealing to the jury to convict his client, so that the case might be carried to a higher court on appeal.

Mr. Scopes was accordingly adjudged "guilty"; and the case will come before the supreme court of the State of Tennessee in September. This tribunal may do one of two things: either decide that the lower court was in error in certain of its rulings and remand the case for re-trial, or declare the statute to be contrary to the constitution of the State. Appeal may also be taken to the United States supreme court, on the ground that the statute is in violation of certain clauses in the Bill of Rights appended to the United States constitution. Of course it is impossible to predict the outcome of either of these appeals.

Certain after-effects of this case have already been making themselves felt. An anti-evolution bill, similar to the Tennessee statute, offered in the Georgia State legislature, was decisively defeated by a viva voce vote. The "fundamentalists" wish to introduce a similar measure at the next session of the national congress, but so far have been unable to find a member willing to sponsor such a bill. An effort to enforce a dead-letter clause in the regulations of the Washington, D.C., schools appears to have gone off as a flash in the pan.

The effort to force an Old Testament theocracy upon the American people will continue, but now that the only champion of the movement who enjoyed national prominence has passed away, his cause will probably dwindle accordingly.

Relativity Displacement of Spectral Lines and Stellar Constitution.

NOT many months ago, a very careful and critical examination by Dr. C. E. St. John of the wave-lengths of the lines in the solar spectrum was sufficient to convince a large body of astronomers that the displacement towards the red of spectrum lines originating in a region of high gravitational potential, required by Einstein's theory of relativity, was an actual phenomenon. An element of doubt remained, however, owing to the exceedingly small amount of the displacement in question and the unknown effects of convection currents and other disturbing influences in the solar atmosphere.

At the time when Dr. St. John's investigation was made, it appeared that no source of light other than the sun could afford a satisfactory test of Einstein's prediction; and that for two reasons. In the first place, the smallness of the displacement to be measured demanded a degree of dispersion and perfection of detail in the spectrum which it was impossible to obtain with the light of any other astronomical body. The relativity displacement depends on the gravitational potential at the surface of a star—that is, on the star's mass divided by its radius—and for no star was this quantity believed to be large enough to give a displacement of more than one or two hundredths of an Ångström unit. In the second place, owing to the identical character of the relativity displacement and the Doppler displacement arising from motion of a source of light away from the observer (both displacements are proportional to the wave-lengths of the lines concerned), it was necessary to select a body the motion of which relative to the earth was known from independent evidence. Since the radial velocities of the stars can be obtained only by means of the Doppler effect, the sun was for this reason also the only body available for the Einstein test.

The restriction thus doubly imposed has now been removed, thanks jointly to some remarkable theoretical predictions by Prof. A. S. Eddington and the extremely fortunate circumstance that Nature has provided a means of testing those predictions. Certain facts of observation recently led Eddington to the conclusion—which he immediately saw to be a natural consequence of his theory of the constitution of the interior of a star—that matter under stellar conditions might attain densities many thousand times greater than those with which we are familiar among terrestrial materials. Not only so, but in the stars known as "white dwarfs," of which two are known, it appeared that these high densities might actually be realised.

These stars are abnormally faint for their spectral type and colour—a fact which suggests that they have very small surface areas and correspondingly large densities; a given spectral type or colour denotes a definite surface brightness per unit area, and an abnormally small total output of light must therefore mean an abnormally small radiating area. Further, the stars are members of binary systems, and their masses can be determined and hence the order of magnitude of their densities. One of the white dwarfs is a companion of Sirius, and therefore one of the nearest of the stars. This fortunate circumstance has just enabled Dr. W. S. Adams of Mount Wilson Observatory (Proc. Nat. Acad. Sci., Vol. 11, No. 7, July 1925) to observe its spectrum in spite of its low intrinsic brightness, and thereby to confirm both Eddington's prediction and the reality of the Einstein gravitational displacement.

The existence of stars having the extraordinary qualities of the white dwarfs removes the necessity of confining the Einstein test to the sun. The extreme compression of the material of the star involves a very high value of the gravitational potential at the surface, and the relativity displacements are of the order of half an Ångström unit. There is therefore no need to use the high dispersion which would be necessary with normal stars. Further, owing to the fact that the star is a companion of Sirius, the space velocity of the two stars must be the same when allowance is made for the orbital motion. All that it is necessary to observe, therefore, is the difference in displacement between the lines of Sirius and those of its companion. This difference, except for the known amount due to orbital motion, must therefore be due to the excess of Einstein displacement in the companion over that in Sirius itself. Working on these lines, Dr. Adams has found almost indubitable evidence of the existence of an Einstein shift of the expected order, and a mean density of the order of 53,000 (water=1).

This remarkable result, which marks a very definite advance in our knowledge of both the foundations of science and the constitution of matter, is interesting on account of the chance which has made it possible as well as for its own intrinsic importance. Had it not been for the fact of the existence of a white dwarf which is, at the same time, one of the nearest of the stars and a member of a binary system of which the other star is a normal one, the confirmation could not have been made.

Current Topics and Events.

IN *Die Naturwissenschaften* of July 17 there appears a report of an address by Prof. Miethe on the production of gold from mercury, from which it seems that, in a mercury vapour lamp operated under suitable conditions, gold actually makes its appearance in amounts amenable to chemical tests. The necessary conditions are rather difficult to define, but with a suitable form of discharge, the gold yield is proportional to the current strength and the time. A definite potential is necessary before

any appreciable quantity is observed. A mercury vapour lamp *in vacuo* is ineffective, but the same discharge in air at atmospheric pressure gives measurable amounts of gold. Again, gold is found after a discharge between two mercury electrodes in paraffin wax, in this case the gold makes its appearance not in the liquid mercury but in the wax along the path of the discharge. In certain experiments even greater quantities of a metal which closely resembles silver are found.

These results are largely confirmed by Prof. Nagaoka's work recently described in *NATURE* of July 18, p. 95. Prof. Miethe attributes the appearance of the gold to the disintegration of mercury atoms under the influence of electronic bombardment. In this report no reference is made to the energetics of the problem, nor is any suggestion given as to the mechanism of disintegration. The author admits that the appearance of silver, if silver it is, as a disintegration product of mercury is certainly not to be expected, although, under suitable energy conditions, the conversion of mercury into gold might be anticipated. In the same issue there is published a letter from Dr. Hönigschmidt giving 197.26 as the atomic weight of the gold thus produced, a value identical with that of ordinary gold. This determination, in conjunction with Dr. F. W. Aston's measurements of the isotopes of mercury reported in a letter to *NATURE* of August 8, p. 208, throws doubt on the transmutation theory.

THE Forestry Commissioners' fifth annual report for the year ending September 30, 1924, shows that steady progress in the work of afforestation in Great Britain has been maintained. During the five years, 1919-1924, the area actually planted by the Forestry Commission was 39,469 acres, of which 37,790 acres were with conifers and 1679 acres with oak, beech, and other hardwoods. In addition, grants made to public bodies and private persons have resulted in the planting (or preparation, with undertaking to plant) of 42,082 acres. The total area planted under the auspices of the Commission was thus 81,551 acres. The Commissioners' planting work is entirely dependent on the timely acquisition of suitable land and on the raising of sufficient young trees in forest nurseries. It is satisfactory then to learn that the Commission has acquired 141,470 acres of plantable land, of which approximately 190,000 acres represent an addition to the existing forest area of Great Britain, the remainder being felled or devastated woodlands. The nurseries established are extensive, and last year's planting of 10,519 acres absorbed more than 22 million young trees. On April 1, 1924, the Crown Woods, aggregating 120,648 acres, were transferred from the Commissioners of Woods and Forests to the Forestry Commissioners, and will be managed on the same principles as estates acquired for afforestation. The sixteen Crown Woods (New Forest, Dean Forest, etc.) and the new areas, thirty-four in England and Wales and twenty-eight in Scotland, where planting on a large scale is being carried on by the Commission, are shown in two maps. The largest of these planting centres is near Thetford in East Anglia; and here a forest of 20,000 acres is in the making. The report gives a full account of the various forestry operations, and is replete with tables and statistics. It has been issued as a Parliamentary Paper (No. 107, price 1s.).

SIR ARTHUR KEITH's description of the fragments of the skull found by Mr. Turville-Petre in a cave near the Lake of Gahlee, which appeared in the *Times* of August 14, confirms the preliminary report that it is to be assigned to the Neanderthal type. It departs

from that type, however, in certain characters in which it appears to approach the type of modern man. Although resembling most closely the Krapina variety of Neanderthal man, the Galilean man differs from that and all other European specimens in having a narrow and high-vaulted skull, and though the eyebrow ridges are massive and strong, the bone enclosing the brain is not thicker than is the rule among modern Europeans. The breadth above the ear-holes is estimated at 120 mm. and the extreme length at 200 mm., while the volume of the brain may be inferred to have been little short of that of the average modern Englishman, which measures about 1480 c.c. A further note by Mr. Turville-Petre suggests that the flint implements represent a transition culture between Acheulean and Mousterian. The predominant types are *coups de poing*, mainly small in size, side-scrapers, trimmed flakes, narrow blades, many retouched along one edge, and small amygdaloid flakes retouched on the upper surface to form Mousterian points. Anthropologists await with much interest the fuller report on the skull, and the account of the excavation of the cave to be given by Sir Arthur Keith and Mr. Turville-Petre to the anthropological section at the forthcoming meeting of the British Association at Southampton.

WE have received from Mr. W. Spencer Lake, 248 Valentine Street, Bendigo, Australia, a letter in which he comments on Prof. Lloyd Morgan's article on "Optical Records and Relativity" (*NATURE*, October 18, 1924, p. 577). In view of the divergence of view with respect to interpretation of *mental reference* to what we speak of as objects of vision, Prof. Lloyd Morgan asked whether it is for the physicist to pronounce judgment. Mr. Spencer Lake is of opinion that though most physicists appear to subscribe to the hypothesis of direct apprehension, yet it is doubtful if many could be found who would assert this unshaken confidence in it. Rather would they admit that they are concerned with sensual images and a "construct-world" formed by them therefrom. It seems to him that the physicist is not called upon to explain to which hypothesis he subscribes because it can in no way affect the physical issue. With regard to the transformations of relativity, they refer not to events in general but to measures and to physical quantities defined by these measures. These measures—spatial and temporal—are arbitrary. They depend upon "local spaces" and "local times." What relativity asserts is that, underlying all points of view and all measures, however arbitrary, there is some element of "invariability," not in the absolute sense, but in the sense that there is something which is independent of point of view, independent of the particular measure-code adopted, and to be regarded as a "law of Nature." The transformations of relativity apply to the quantitative equations by which these laws are expressed. Thus relativity helps to bring us to a better knowledge of the physical world by eliminating what, in our experience, depends upon the local space and time system, for example, the very special space-time frame of classical mechanics. It is not a question of whether the laws

of classical mechanics stand in need of revision or not, but whether the physical world is the same for us as it was before the advent of relativity.

WE have received Vol. I, Part I of the Journal of the Ipswich and District Natural History Society. It will be remembered that this Society was founded on January 1, 1924, as the result of an amalgamation of the Ipswich and District Field Club and the Ipswich Scientific Society. The Society now numbers 250 members, and is divided into six sections, dealing respectively with botany, conchology, agriculture, prehistoric archaeology, microscopy, and photography. The president is Mr. J. Reid Moir, whose address on "The Antiquity of Man in Ipswich" appears as the first communication in the Journal. Other communications deal with the evolution of the river Stour, by Prof. P. H. G. Boswell, the Suffolk and Essex Crag Pits, by Mr. Alfred Bell, Mr. J. Reid Moir, and the late Mr. S. A. Notcutt; and the Suffolk Coast, by Major E. S. Cooper, who traces changes in the coast-line from the earliest times. In view of the importance of the subject we may direct the special attention of students to the paper by Messrs. Bell, Notcutt, and Reid Moir, in which the two former give a list of the crag pits, the types of deposit to be found in each, and directions for reaching them, while the latter deals with the character of the sub-crag detritus beds, and the implements found therein, as well as sites on which each may be best studied.

THE Report of the Board of Visitors appointed by Congress to inquire into the work of the Bureau of Standards at Washington has been issued, and contains much valuable information as to the benefits which have accrued to the United States from the activities of the Bureau. The motor car industry alone has been able to effect economies amounting to 3,000,000*l.* per annum on account of the investigations on fuels, tyres, and brake linings carried out at the Bureau, while the annual grant to the institution has been less than 400,000*l.* The Board emphasises the necessity of more fundamental scientific research, which runs the risk of being given a secondary position in an establishment on which the public makes demands for immediate and profitable returns. A similar point was made by the president of the Société d'Encouragement pour l'Industrie nationale in France in his address at the recent annual meeting, when he spoke of the importance of aiding those who are carrying out research by placing in their hands the instruments they need and the books and periodicals they must read. Owing to the extensive adoption in France of the English Saturday half-holiday, the number of readers who consult the library of the Society on that day has greatly increased.

H.M. STATIONERY OFFICE has of late earned our gratitude by producing many valuable reports in a form that is not merely cheap but also pleasing. Now it has still further marched with the times by placing on sale (price 3*d.*) at the Government Pavilion of the British Empire Exhibition a "Brief Guide to Government Publications," which is as well and

attractively written as any advertisement by a large business house. The section on "Science and Technology" occupies five of the twenty-two pages devoted to a descriptive classification, and that without including archaeology, agriculture, or fisheries. For details the reader is referred to the lists issued by the Departments concerned. It is a pity that the Stationery Office should not feel called upon to mention the numerous and important publications of the British Museum; at any rate it publishes the Annual Return of that establishment. But even as it is, the field to which this pamphlet guides one is astonishing in its extent and variety; few can be familiar with more than a small corner of it.

AN interesting account by Francis Buckley of the glasshouses on the Wear in the eighteenth century appears in the Journal of the Society of Glass Technology for June. Between 1696 and 1737 at least three glasshouses were built on the Wear, probably by a syndicate called the "Company of Glass-Owners at Sunderland." It is interesting to note that the owners either let the glasshouses or, failing that, worked them themselves. About 1741, many glass-makers on the Tyne considered it advisable to acquire the two glasshouses at Sunderland, but the project fell through. The paper contains many interesting extracts from contemporary newspapers.

THE ever-increasing interest in the problem of securing a purer atmosphere with its resulting benefits should receive further impetus from the Conference to be held at the Palace Hotel, Buxton, on October 2-5, under the auspices of the Smoke Abatement League of Great Britain. Practical proposals for reducing both domestic and industrial smoke are being prepared by the League for full consideration by those attending, and prominent individuals have agreed to open discussions at various sessions. It is hoped that a constructive programme of useful work will be initiated, the results of which can be reviewed at the Smoke Abatement Exhibition and Conference at Birmingham in 1926.

DURING Lord Burnham's absence abroad the Duke of Atholl has consented to act as chairman of the Special Appeal Committee of the Imperial College of Tropical Agriculture. The first large donation received since he has "fathered" the Fund is one of 1000*l.* from Messrs. J. and P. Coats, Ltd. This generous gift, following closely upon a contribution of 1000*l.* from the Liverpool Cotton Association, is evidence of the interest which is taken in the Imperial work of the College by the cotton industry. Further contributions from those whose interests lie in tropical agriculture should be sent to Mr. Algernon Aspinall, Secretary, The Imperial College of Tropical Agriculture, 14 Trinity Square, London, E.C.3.

DR. GEZA RÓHEIM, of Budapest, whose reputation as an exponent of the application of psycho-analytic methods in anthropological research has grown steadily since the War, and whose study of Australian totemism on psycho-analytic lines has recently been published in Great Britain, will visit England in the

month of September. During his stay he will read a paper on Hungarian folklore and primitive beliefs at the Royal Anthropological Institute on a date to be announced later. Arrangements are also being made for Dr. Róheim to deliver a course of four lectures on psycho-analysis and primitive religion and magic for the Institute of Psycho-Analysis. Further particulars may be obtained from Mr. John Rickman, the hon. secretary of the Institute of Psycho-Analysis, 26 Devonshire Place, W.1, or at 42 York Terrace, N.W.1. There will be no charge for admission to Dr. Róheim's lecture at the Royal Anthropological Institute, but application for the admission of non-members should be addressed to the hon. secretary, 52 Upper Bedford Place, W.C.1, after September 1.

MR. F. EDWARDS, 83A High Street, Marylebone, W.1, has just issued an interesting catalogue (No. 471) of second-hand books, maps and charts relating to nautical subjects and the South Seas. Nearly 1400 works are listed, some of which are rare. The list can be obtained upon application.

IN catalogue No. 429, Messrs. Bowes and Bowes, Cambridge, offer for sale some 1100 second-hand volumes from the library of the late Dr. F. J. H. Jenkinson, librarian of the University of Cambridge. The books are of a miscellaneous character, but include some dealing with scientific subjects.

MESSRS. W. Heffer and Sons, Ltd., Cambridge, announce for publication in the autumn "Stars and their Uses," by E. B. Leggett, a little volume in verse beginning with an introductory definition of common astronomical terms and proceeding to treat of the earth in its relation to the universe. In

successive chapters it deals with the constellations, circumpolar, zodiacal, and otherwise, and concludes with remarks on the general composition of celestial bodies.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: Two assistants in the department of zoology and comparative anatomy of University College, London, namely, a man, preferably with some training in physiology or chemistry, for an appointment renewable annually, and a man or a woman to take the place of an assistant absent on a year's leave—The Secretary (August 24). An assistant lecturer in the department of pharmacy of the Technical College, Sunderland—The Chief Education Officer, 15 John Street, Sunderland (August 31). A research chemist, a research engineer, and some junior research chemists at the Chemical Laboratory of the Department of Scientific and Industrial Research, Teddington—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1 (September 4). An assistant lecturer in building construction at the Municipal College of Technology, Manchester—The Registrar (September 25). A senior lecturer in philosophy in the University of Melbourne—The Agent-General for Victoria, Melbourne Place, Strand, W.C.2 (October 15). A temporary engineering assistant in connexion with the Air Ministry—The Secretary (S.I./437), Air Ministry, Adastral House, Kingsway, W.C.2. A junior assistant in the Agriculture Science Bureau of the International Institute of Agriculture—The General Secretary, International Institute of Agriculture, Rome.

Our Astronomical Column.

BORRELLY'S COMET.—A third periodic comet of the six that are due at perihelion in the present year has been found. M. Schaumasse found Borrelly's comet on August 14 at $3^h 18.2^m$ univ. time in R.A. $5^h 4^m 24^s$, N. Decl. $2^\circ 4'$. It was of magnitude 13; the date of perihelion is about October 7.75. The following ephemeris (for 0^h) should be near the truth:

	R.A.	N Decl.
Aug. 22	$5^h 26.5^m$	$3^\circ 57'$
" 30	$5^h 49.0^m$	$5^\circ 56'$
Sept. 7	$6^h 12.0^m$	$7^\circ 58'$

It is a morning object, being on the meridian about $7^h 15^m$.

COMET HUNTING.—Mr. W. Reid, who has been the most successful comet hunter of recent years, contributes an interesting note on his methods to the Journal of the Astronomical Society of South Africa, vol. 1, No. 5. It is particularly seasonable, since there are apparently no systematic workers in this field in the northern hemisphere, so that an amateur would have good prospects of success in it.

Mr. Reid laid down for himself the large programme of sweeping the whole southern hemisphere once a month: he found it advisable to map all the nebulae that might be mistaken for comets. His instrument is a 6-inch Cooke photo-visual equatorial; its definition is very fine, a point that he lays stress upon. He makes north and south sweeps in a fixed hour angle, the diurnal motion sufficing to give a new star field at each successive sweep. One night is devoted to the western sky, another to the eastern. There is

little use in sweeping in moonlight or with bad seeing. He notes that he often sweeps for five hours or more on a good night, and yet his catches average about one per annum, so that the work requires much patience and perseverance, but he notes the sense of intense satisfaction that success brings.

NORMAN LOCKYER OBSERVATORY, SIDMOUTH.—The report of the Director of the Norman Lockyer Observatory, Sidmouth, for the year ended March 31 last, shows that much valuable work has been accomplished during the year. Five papers on various branches of astronomy have been published, and six others are in preparation. The year was, nevertheless, a very unfavourable one with respect to weather conditions, only 133 nights having been sufficiently clear for observations to be possible; of these, all but three were utilised. During the year the first assistant, Mr. W. B. Rimmer, left the Observatory to take up an appointment at the Canberra (Australia) Solar Physics Observatory, and from November 29 onwards the work was conducted entirely by the Director (Dr. W. J. S. Lockyer) and the chief assistant (Mr. D. L. Edwards). The principal work undertaken and completed during the year was the determination of the spectroscopic parallaxes of certain stars and the study of the spectra of some bright-hydrogen-line stars. The accounts show an excess of 73% of expenditure over income, but it is hoped that, by the formation of an endowment fund, the deficiency of assured income below normal expenditure will be considerably reduced.

Research Items.

A LATE BRONZE AGE SITE IN SOUTHERN BAVARIA—The results of an investigation of a site near Istein in Southern Bavaria are described by Dr R. Lais in vol. 24, Pt. 2, of the *Bericht der Naturforschenden Gesellschaft zu Freiburg*. The finds, some of which have an important bearing on the distribution of ceramic ornament in this part of the Central European area in the later Bronze Age, were derived in part from the surface, in part from excavation. Among them were a very fine triangular arrow-head of chert, polished stone axes, stone knives, clay spindle-whorls of double-cone shape and pottery, mostly fragmentary, but of sufficient size to show the character of the ornamentation. The decoration was in the form of rings in relief, incised dots and marks in lines and groups, parallel grooves, zigzags and dog's tooth. It was uniformly geometric with the single exception of a garlanded ornament or series of festoons composed of grooves. In regard to dating, the arrow-head, axes and knives clearly belong to the Neolithic Age, as do the numerous flint-flakes which were found, although some of these would appear to have been used later for the purpose of strike-a-lights. The pottery, however, belongs to a later period and may be an extension of the culture of the Black Forest. It is compared with pottery from an urn-burial at Rheinweiler, 5 km. to the north, and from Aichen, 50 km. to the east. These two finds are to be attributed to the Bronze Age rather than the early Iron Age as has been suggested. The Istein finds may be assigned to the latest phase of the Bronze Age.

ABILITY OF TERMITES TO LIVE ON PURE CELLULOSE.—In his studies on termites, Dr. L. R. Cleveland has shown that through the agency of the protozoa in their alimentary canal, they are able to digest wood and utilise the products. He has kept numerous termites belonging to two genera *Termopsis* and *Reticulitermes* in glass vessels and has fed them for eighteen months on cellulose alone, e.g. filter paper (*Biol. Bulletin*, April 1925). These termites fed on a pure cellulose diet have behaved exactly as the controls fed on wood. Many of the nymphs have become sexually mature adults and have laid a large number of eggs which have hatched normally. Larvæ from these eggs have grown even more rapidly than those from eggs laid by some of the wood-fed controls. In all the experiments the larvæ now present are greater in number and in weight than the individuals present at the beginning, and no deaths have occurred. Some of the colonies which began with ten adult termites now include more than two hundred half-grown individuals. Attempts have been made to determine whether atmospheric nitrogen is being fixed in connexion with the formation of proteins, but no definite result is as yet forthcoming.

THE OVIPOSITION RESPONSE OF INSECTS.—Bulletin 1324 (April 1925) of the U.S. Department of Agriculture is devoted to this subject. Its author, Mr. Charles H. Richardson, discusses the various stimuli which affect the oviposition reaction of insects, giving a large number of references to the literature on the subject. Temperature is an important factor, and within the range of each species of insect there is probably an optimum temperature for egg-laying. Thus, in the case of the Codling moth, oviposition becomes checked at 18.3° C. and was found to cease at 16.7° C. (Isely and Ackerman). Humidity is likewise very important in many but not all species: by increasing the atmospheric moisture from 55 per cent to 96 per cent., egg-laying in *Tomiscus typhographus* was delayed from 1 to 7 days (Hennings). Light stimu-

lates oviposition in the house fly but is without effect on the egg-laying responses of *Drosophila melanogaster* (Adolph). Surface contact is a further factor and often very important: thus, in the webbing clothes moth, investigations by Benedict and by Titschack suggest that the tactile stimulus may be the determining factor regardless of the food value of the material for the future larvæ. Many insects have been found to be attracted by specific odours, but in many cases the nature of the substratum has also to be taken into account in order actually to induce oviposition. The simplest oviposition responses are probably shown by those insects which pass most of their lives associated with substances that serve as food for themselves and their offspring. Most free-living insects, however, require a chain of stimuli to induce normal egg-laying.

PIPERINE AS A MOUNTING MEDIUM—Watson's *Microscope Record* (No. 5, May 1925) contains a useful article by Mr. Chapman Jones, urging the value of piperine as a mounting medium for certain purposes. Its refractive index is 1.68 for the D line, and as it is colourless it is superior to realgar. To avoid crystallisation in permanent mounts, it should be heated to 180° C. for one hour before use, but this is unnecessary for temporary mounts.

TEMPERATURE OF GROUND WATER.—In a pamphlet issued by the United States Geological Survey (Water-Supply Paper 520 F), Mr. W. D. Collins gives a summary, with maps and diagrams, of water available for industrial purposes in the United States. The temperature of ground water is generally from 2° to 3° F. above the mean annual air temperature if the water is between 30 and 60 feet below the surface. At a depth of 10 feet the temperature may range from 10° above to 10° below the mean annual temperature. An approximate average increase may be taken as 1° for every 64 feet. The mean monthly temperature of surface water is generally within a few degrees of the mean monthly air temperature when the latter is above freezing point. In the warmer months the maximum water temperature is usually 2° to 6° higher than the mean monthly water temperature.

ANTARCTIC TERRESTRIAL MAGNETISM.—The first volume of Series B of the Scientific Reports of the Australian Antarctic Expedition of 1911-1914 under the leadership of Sir Douglas Mawson is devoted to terrestrial magnetism. The field observations are dealt with by Mr. E. N. Webb, and Dr. Chree discusses the magnetograph curves. The instruments were lent by the Carnegie Institution of Washington and consisted of two magnetometers, a Dover and a Lloyd-Creak dip circle. Observing stations were established on Macquarie Island, at Cape Denison, Adelie Land, and at Queen Mary Land, and sledge journeys were made along the coast, across Adelie and King George Land, towards the magnetic pole, and across Queen Mary and Kaiser Wilhelm Lands. As a result, the south magnetic pole was found to be at 71° 10' S., 150° 45' E., and the lines of equal dip to be ellipses with their major axes north-west to south-east. The horizontal component of the field was found, partly by the magnetometer, partly by the dip circles, which were provided with deflecting needles. The polar diagrams showing the daily variation of the north and west components are slightly elliptic with their major axes east and west for Adelie Land, while the Scott expedition found them nearly circular for Cape Evans.

WEATHER AT HONG KONG.—An annual summary of the meteorological elements at Hong Kong, with the typhoon tracks in the neighbouring sea and the results of magnetic observations during 1924, are given in the *Monthly Meteorological Bulletin* for December last. The discussion is prepared under the direction of Mr. T. F. Claxton, the Director of the Royal Observatory. No text is given with the voluminous tables, but the latter are prepared with great care and precision. Barometric pressure uncorrected for height above sea-level ranged during the year from 30.31 in. in November to 29.37 in. in July; the highest monthly mean was 30.06 in. in January, and the lowest 29.60 in. in July. Air temperature in the shade ranged from 93° F. in September to 48° F. in January; the highest monthly mean was 82.2° F. in September, the lowest 60.3° F. in February. The total rainfall for the year was 98.57 in., which is nearly 14 inches more than the normal for 40 years; the monthly fall was heaviest in June, but the maximum in an hour was 1.74 in. in May. The brightest month was November with 254 hours of sunshine, and December was the next brightest with 238 hours. The maximum hourly wind velocity was 46 miles in October; the highest in a squall was at the rate of 69 m.p.h., also in October. Two plates are given showing the tracks of typhoons and depressions in the Far East during the year 1924; the tracks very often pass north-eastwards over the neighbouring sea, but others strike inland, passing from east to west in the neighbourhood of Hong Kong. The report of the Royal Observatory, Hong Kong, for 1924, shows that Hong Kong was not visited by a typhoon during the year.

THE DISINTEGRATION OF NITROGEN AND OXYGEN.—The volume of Communications from the Vienna Institute for Radium Research for 1923-24 contains a paper by Dr. G. Kirsch on the disintegration of nitrogen and oxygen by means of swift α particles from radium C. The nitrogen was prepared from the air by absorption, the oxygen from pure potassium permanganate, and the scintillations produced by the products of the disintegration were observed on a zinc sulphide-copper phosphide screen. For nitrogen the expelled α particles have ranges up to 11.4 cm., and the H particles up to about 28 cm. For oxygen the great majority of the α particles have ranges less than 9.3 cm., but there is evidence that for ranges in excess of 9.3 cm., H particles are present in greater abundance than α particles, so that it is not safe at present to conclude that in the disintegration of oxygen H particles are not produced. The author considers that the experimental facts support Pettersson's theory that the α particle causes an explosion of the nucleus, the products moving away in all directions equally, rather than the theory of Rutherford and Chadwick, that the momentum of the α particle is communicated by impact to a portion of the nucleus.

THE RESONANCE LINES OF NEON.—The spectrum of neon in the extreme ultra-violet has been recently investigated by Dr. G. Herz, using a vacuum grating spectrograph (*Zeitschrift für Physik*, June 30). Two strong lines, with the wave-lengths 735.7 ± 0.5 Å.U. and 743.5 ± 0.5 Å.U., have been photographed, the frequency difference between them being 1428 ± 3 cm.⁻¹, which agrees with the difference between Paschen's $1s_2$ and $1s_4$ terms. The two lines are to be regarded as combinations of these two terms with the fundamental term, and are the resonance lines of neon. Paschen had already resolved the spectrum of neon into a complicated system of series; but the term

corresponding to the normal condition of the gas was not determined by him, as these extreme ultra-violet lines had not been observed. The author concludes that the normal state of neon is a p state, and that the inner quantum number to be ascribed to the fundamental term is $J = \frac{1}{2}$ (Lande's notation), or $j = 0$ (Sommerfeld's notation). A provisional value for the magnitude of the fundamental term is 173970 ± 100 cm.⁻¹, but more accurate measurements of the wave-lengths are necessary to obtain a definite value. The paper contains an account of the apparatus made use of in obtaining these results. Owing to the strong absorption of the resonance lines in neon, it was necessary to use a low voltage arc in close proximity to the slit, in a space filled with pure neon at about 4.5 mm. pressure. The light passed through the slit into the spectrograph tube, the pressure of the pure neon in which was about one-thirtieth of this, so that although the light had to pass through a considerable distance to the grating and then to the photographic plate, the absorption was not excessive, and satisfactory photographs of the two lines were obtained. The two ionisation voltages of neon as calculated from these observations are 21.47 and 21.57 volts. This agrees well with the value 21.5 volts measured by Hertz, using the electron collision method.

NITROGEN FIXATION.—The mechanism of the fixation of nitrogen as sodium cyanide has been investigated by E. W. Guernsey and M. S. Sherman, who have published their results in the *Journal of the American Chemical Society* for July 1925. In the process, sodium carbonate and carbon are heated with finely divided iron as catalyst; the equation of the total reaction is $\text{Na}_2\text{CO}_3 + \text{N}_2 + 4\text{C} = 2\text{NaCN} + 3\text{CO}$. It is now shown that the intermediate reactions are (i.) the reduction of sodium carbonate to metallic sodium, (ii.) the formation of sodium carbide from the elements, and (iii.) the absorption of nitrogen by gaseous sodium carbide to form sodium cyanide. Iron has a marked catalytic effect on the absorption of nitrogen by sodium carbide but does not appear to be essential for the reduction of sodium carbonate or for the formation of sodium carbide.

ORGANO-ARSENIC COMPOUNDS.—An account of the chemotherapy of organo-arsenic compounds, by Dr. G. M. Dyson, is published in the *Chemical Age* for July 25. Ehrlich was the first to raise chemotherapy to the level of a science. Three separate aspects of disease treatment attracted his attention, namely, the disappearance of malaria parasites from the blood by the administration of quinine, the decrease of syphilitic symptoms with the use of mercury, and the destruction of various trypanosomes and spirillæ by the use of arsenic compounds. Ehrlich considered some chemical combination occurred between the drug and some specific chemical group in the parasite (receptor group), thus either killing the parasite outright, or preventing it from functioning in an injurious manner (parasitotropism). The most vital problem in the chemotherapy of receptor groupings is that of determining the relationship between chemical constitution of the curative compounds and their pharmacological action on the receptor groups. Working on these lines, Ehrlich discovered the enormous spirillicidal activity of compounds containing the arseno group, $-\text{As}=\text{As}-$. The manufacture of salvarsan, the most important and valuable remedy for syphilis, is described fully. Other arsenic compounds, still more or less in the experimental stage so far as therapeutic action is concerned, are also described.

Southampton Meeting of the British Association.

PROVISIONAL PROGRAMMES OF SECTIONS.

FROM the local arrangements outlined in our issue of August 15, p. 251, and from the provisional programmes of the sections, it is evident that all who attend the Southampton meeting of the British Association will find that the time is very fully occupied. The brief statements below of outstanding features of some sectional programmes, for which we are indebted to the respective recorders, will serve to indicate the fare which is to be set before the members of the Association.

SECTION A (MATHEMATICS AND PHYSICS).

The programme of Section A (Mathematics and Physics) presents some interesting and novel features. Under the presidency of Dr. G. C. Simpson, Director of the Meteorological Office, the subject of meteorology will naturally receive considerable attention, which is in keeping with the great present-day importance of this branch of science.

The business of the Section opens on Thursday, August 27, with a paper by Prof. Orstein of Utrecht, foreign guest of the Association, on the quantum theory of dispersion; he will be followed by several speakers on subjects in spectroscopy. The presidential address on Friday on the new ideas in meteorology will demonstrate the great strides which have been made in the subject in the last decade. The president will be supported by the leading meteorologists in Great Britain, several of whom have promised papers to which the Friday and a portion of the Tuesday sessions will be devoted. On Monday, August 31, there will be a joint discussion with Section C (Geology) on "Variations in Gravitational Force and Direction and its Relation to Geological Structure," a subject upon which a committee of the Section has been working for some time, and upon which many physicists will welcome information because of its considerable industrial import. On Tuesday, September 1 Prof. Appleton will discuss some problems in thermionic valves, and he will be followed by several speakers on allied problems.

An excursion to the Air Ministry Seaplane Station at Calshot has also been arranged.

SECTION B (CHEMISTRY).

One of the features of the meeting of Section B (Chemistry) will be a joint discussion with Section G on the ignition of gases. This will take place on the Friday morning, and will be opened by Prof. H. B. Dixon. Two other discussions have been arranged by Section B, one on Thursday morning, having for its subject surface catalysis, which will be opened by Dr. E. K. Rideal, and the other on Tuesday morning, on the alternating effect in carbon chains, to be opened by Dr. B. Flurscheim.

The presidential address to the Section will be delivered on the Monday morning, when Prof. C. H. Desch will take as his subject "The Chemistry of Solids."

Among other papers of general interest which will be submitted to the Section, mention should be made of a contribution by Prof. E. C. C. Baly entitled "Further Investigations on the Photosynthesis of Naturally-occurring Compounds," a paper by Prof. H. E. Fierz, of Zurich, on "The Liquefaction of Wood and Cellulose and some General Remarks on the Liquefaction of Coal," and a paper by Mr. E. A. Ollard, of the Metropolitan-Vickers Electrical Company, on "The Resistance to Corrosion of Electrodeposited Chromium."

SECTION E (GEOGRAPHY).

Owing to this year's meeting being held in Southampton, the home of the Ordnance Survey, Section E (Geography) will devote special attention to papers on survey and cartography. Col. Com. E. M. Jack will speak on the work of the Ordnance Survey and Captain J. G. Withycombe on its recent productions. Mr. O. G. S. Crawford will deal with archaeology in survey maps. Mr. A. R. Hinks is to devote his presidential address to the science and art of map-making. The relations between geography and anthropology are evident in a paper by Mr. H. Sumner on geography and prehistoric earthworks in the New Forest. The present state of the international map on the scale of 1/1,000,000 is to be described by Major M. N. Macleod, and the question of pronunciation tables for the British sheets by Mr. J. H. Reynolds. In exploration and field work, Prof. J. W. Gregory will discuss the problems of the Queensland Barrier Reef and the most suitable site for boring, while Mr. F. G. Binney will give an illustrated lecture on his recent travels in North-East Land, Spitsbergen. Dr. Vaughan Cornish introduces a new subject in his paper on subjective variations of magnitude in natural scenery. A paper of current interest will be that of Mr. F. J. Richards on the cultural geography of India. Prof. W. M. Hobbs will contribute a paper on the glacial anticyclone.

SECTION F (ECONOMIC SCIENCE AND STATISTICS)

Two matters of great importance at the present time, both to economists and to farmers, are to be discussed in a joint session of the Agriculture and Economic Sections. One is the question of farming costs in relation to farm management, on which a paper is to be read by Mr. J. Wyllie; the other will be raised in a paper by Mr. R. B. Forrester on the marketing of agricultural produce. In the present crisis in British farming these two papers are of especial interest.

At a time, too, when wages problems in our chief industries are pressing for solution, the address of the president, Miss Lynda Grier, on the meaning of wages is equally timely. This paper will be supplemented by one by Mrs. Stocks on the economics of family endowment, and another by Mr. R. F. Harrod dealing with trade crises and the distribution of wealth among the factors producing it. The problem of population is to be considered in two papers, one by Mr. G. F. Shove on the law of diminishing returns in agriculture and its bearing on population, the other by Mr. P. Sargent Florence on "Over Population and the Statisticians."

Two aspects of the financial situation will be considered. Mr. R. G. Hawtrey will deal with the gold standard and the balance of payments, and Mr. P. B. Whale with German finance and the Dawes report. In addition there are papers by Miss I. F. Grant on the enclosure movement and Scottish arable land, by Mr. Fabian von Koch on unemployment relief in Sweden, and by Dr. John Hulme on recent developments in Italy's textile trade.

A new feature this year is the Transport Sub-section. Six papers are to be read, dealing with the technical and economic aspects of transport by railways, roads, canals, and docks.

SECTION G (ENGINEERING).

The president of Section G (Engineering), Sir Archibald Denny, will deliver an address on "Fifty

Years' Evolution in Naval Architecture and Marine Engineering." During this period very remarkable developments have taken place in the construction and equipment of ships, and in this development science and scientific research have played a very important part.

After the presidential address Mr. Edwin R. Mumford will discuss the important question of the comparison between the speeds and powers of models and ships, and after an account of the pioneer work of Dr. William Froude, will show how the method has been applied to solve numerous problems of ship and propeller design; the problem of "cavitation" will also be discussed. Mr. Foster King will trace the development of the scantlings of modern steel ships and show the hindrance to development which resulted from strength calculations not having been used in wood construction. Mr. F. E. Wentworth Shields will describe the quay walls of Southampton, certain of which have been proved unstable owing to the nature of the foundations. He will give the history of the walls and discuss the various remedies adopted to render the walls stable. Mr. W. G. Turner will describe the electric power station at Southampton, and Mr. H. Wauchope will deal with the electric supply and plant of Southampton Docks. Mr. Stanley S. Cook will discuss the efficiencies of steam turbines for marine purposes and the problem of auxiliary machinery and fuel consumption, and Mr. Western Hutchinson will read a paper on "Sailing and Motor Craft, the Scientific Aspects of their Design."

At the joint discussion with Section B (Chemistry) on "Ignition of Gases," Prof. W. T. David will give some account of experiments on the spontaneous ignition of gases and upon the influence of nitrogen and other gases and also infra-red rays upon ignition temperatures and rates of ignition respectively. Mr. C. E. Le Maistre will read a paper on engineering standardisation, and Vice-Admiral Sir Robert Bland Dixon and Mr. T. Berry are to discuss the problem of technical training for naval constructors and engineer officers. Prof. David Ellis will give an account of an investigation into the responsibility of iron bacteria as constructive agents in the formation of incrustation in pipes. In the special case investigated, in spite of every appearance of bacterial responsibility, the incrustation in pipes was found to be due to other causes.

The problem of landslides will be dealt with by Mr. Edgar Morton, and Mr. Oliver E. Simmonds will describe the construction of modern seaplanes. Experimental demonstrations of flow of water in pipes are to be given by Prof. Eustice, and Prof. J. G. Gray is to give demonstrations with the gyroscope. Prof. J. J. Guest is to discuss the dynamics of motor cars. Visits are being arranged to the seaplane station, to Southampton Docks, to an Atlantic liner, to the railway works, aeroplane works, and to Agive oil works.

SECTION H (ANTHROPOLOGY).

In Section H (Anthropology), Dr. T. Ashby in his presidential address will deal with "Engineering in Ancient Rome." In view of his special interest in Romano-British studies, a survey will be made of our present knowledge of Roman Britain in a series of communications dealing with recent excavations in England, Wales, and Scotland. Not only will much of the material of these papers be described here for the first time, but a great deal will be the result of work carried on during the present summer.

In prehistoric archaeology may be mentioned communications by Miss D. A. E. Garrod on the Upper Palaeolithic in Britain; on the Neolithic period by Mr. O. G. S. Crawford, who will deal with changes

of climate and megalithic migrations; by M. Z. le Rouzic on megalithic monuments in Morbihan, France; and by Mr. E. T. Nicolle, who will describe the important Bronze Age mound recently excavated in Jersey. Mr. H. J. E. Peake will raise the question of archaeological distribution maps. Certain aspects of the question of the antiquity of man will be discussed by Sir W. Boyd Dawkins, and Mr. W. P. Pycraft will offer suggestions for a new classification of man. Sir Flinders Petrie's description of recent finds of relics of early man in Egypt is of special interest in view of the correspondence which followed the preliminary announcement of these discoveries in the Press. The Section will also have an opportunity of discussing recent results obtained by the American archaeological expedition to the city of Carthage, which will be described by Mr. Harden.

Other branches of anthropological studies will be well represented, as, for example, by Capt. Pitt-Rivers' account of the natives of the Island of Aua, New Guinea, and their customs and mode of life; and by Capt. Hilton-Simpson's description of the industries of the Shawiya of the Aurès Mountains, Algeria, which will be illustrated by cinematograph films taken by Mr. J. Haseler. Mr. Talbot Rice, a member of the Oxford expedition to Kish in Mesopotamia, will describe the physical characters of the modern Arabs in that area. Some interesting questions relating to heredity in man will be raised by Dr. R. N. Salaman's study of facial types in the Jewish community, which should give rise to a profitable discussion.

Exceptional interest attaches to Mr. Turville-Petre's account of his excavations on behalf of the British School of Archaeology in Jerusalem, in caves near the Lake of Galilee, which have brought to light important evidence bearing on palaeolithic man in Palestine, and Sir Arthur Keith's report on the skull showing affinities with the Neanderthal type discovered there. These communications are the first detailed description of this important discovery to be given in England.

SECTION I (PHYSIOLOGY).

The programme of the Section of Physiology opens with three papers on carbohydrate metabolism, the first of these will be given by Prof. J. J. R. MacLeod, in whose laboratory at Toronto insulin was first prepared, and the second by Dr. C. H. Best, who, together with Dr. Banting, effected the preparation. Prof. MacLeod's communication deals with the carbohydrate metabolism of cold-blooded animals. Dr. C. H. Best will read two short papers on (a) the nature of insulin, (b) the mode of its action. A third paper of considerable interest will be that of Mr. H. P. Marks, who has made some striking observations in relation to the action of the thyroid gland in carbohydrate metabolism. He has found that after prolonged administration of thyroid gland by the mouth to rabbits, a condition ensues in which the injection of sugar produces the same train of severe symptoms as attends the injection of insulin. His results have an important bearing on the cause of the lowered sugar tolerance in hyperthyroidism.

Prof. A. V. Hill, whose work on the mechanism of muscular contraction was rewarded by a share of the Nobel prize for medicine for 1922, will deliver his presidential address on the physiological basis of athletic records on Monday, August 31, and the address will be illustrated by cinematograph. He has analysed the factors limiting muscular effort, and, as a result of observations on the isolated muscle of the frog, has been able to deduce what athletic records should be in man. Work recently carried out in Prof. Hill's laboratory, in which the processes

taking place during continuous activity of the isolated muscle of the frog and of human muscle are directly compared, will be described in a paper by Prof. K. Furusawa on Thursday morning, August 27.

A lecture will be given on Friday afternoon by Mr. J. E. Barnard on the microscopic observation of small bodies. Mr. Barnard's name has, of course, recently been associated with reports of the observation and photographic reproduction by means of ultra-violet light of a cancer virus, the existence of which was demonstrated by Dr. W. E. Gye. The size of some of the bodies has been closely determined and is believed to be 0.072μ , so that Mr. Barnard's achievement is considerable.

On Thursday afternoon there will be a joint discussion with Section D (Zoology) on the functional significance of size, to be opened by Mr. J. B. S. Haldane. On Tuesday morning there will be a joint discussion with Section J (Psychology), to be opened by Prof. T. H. Pear, on the acquisition of muscular skill.

Sectional excursions have been arranged for Monday and Tuesday afternoons, the first to the Anti-Gas School at Tipnor and to the Diving Tank at Portsmouth, and the second to the Fort Grange aerodrome, where some of the tests applied to candidates for the Royal Air Force will be demonstrated.

SECTION J (PSYCHOLOGY).

Differential methods have a prominent place in the programme of Section J at Southampton, where the term "differential" is applied either to a comparison of the reactions to a constant stimulus of two groups differing in one condition, or else to a comparison of the reactions of a group (or two equivalent groups) to two or more different stimuli. Thus a study has been made of special abilities, in arts and science, where "special ability" is meant to apply to a facility developed through special environmental influences and individual interests acting over a number of years and the terms "arts" and "science" stand for the work involved in preparing for first degrees in the corresponding faculties.

Similarly the results of testing physically defective children at the Lord Mayor Treloar Hospital and elsewhere lead to the conclusion that physical defect, if widespread and of sufficiently long duration, produces the symptoms of some degree of amentia; and further, that this mental deficiency resulting from physical defect would appear to be appreciably alleviated by exposure to ultra-violet rays.

In another study, on the discrimination of wool fabrics by the sense of touch, an attempt has been made to define the differences in judgment between members of the wool trade and the consuming public, and the result suggests a method of measuring the wool-trade sense of touch. It is also suggestive of the times that the relationship between buyer and seller is studied psychologically in another paper, where an individual valuation is regarded not as a single price at which the individual concerned will be willing to complete his share of the transaction, but as a whole class of possible prices between which the probability of him completing his share ranges from zero to one.

Our final example is a study of the responses of children when taught by various methods, such as the cinema and oral lessons. The essays written after the various lessons differed in arrangement of material and also in mode of expression or style.

Prof. Spearman will open the sessions with his presidential address on "Mental Law of Diminishing Returns." Two joint discussions will be held, one

with Section L (Educational Science) on "Recent Investigations upon Vocational Guidance," and one with Section I (Physiology) on "The Acquisition of Muscular Skill."

SECTION K (BOTANY).

The presidential address of Prof. Lloyd Williams will deal with the Phaeophyceae and their problems. The investigation of this group of seaweeds has been comparatively neglected, and the conclusions of Prof. Lloyd Williams, who has devoted a life-study to these plants, are looked forward to with keen interest. The study of Algæ will also receive prominence by the communication of several papers on seaweeds.

The only joint discussion in which Section K is participating this year is one with Section E (Geography) on "The Evolution and Colonisation of Tidal Lands," to be opened by Prof. F. W. Oliver, who will speak principally upon the stabilisation of these migrating soils by various types of vegetation. On the geography side, Prof. J. W. Gregory will deal chiefly with the mode of formation of new land areas by the action of the sea. Other speakers in this discussion will be Prof. R. H. Yapp, Dr. Vaughan Cornish, Dr. E. J. Salisbury, and Prof. S. Mangham.

Within Section K there will be a discussion on the interpretation of "Adaptive Characters," which will be opened by Prof. F. O. Bower and contributed to by Prof. J. H. Priestley, Dr. D. H. Scott, and Mr. G. E. Briggs. The argument to be outlined by Prof. Bower will deal principally with certain characters in ferns, to which he has devoted special attention. Prof. Dame Helen Gwynne Vaughan will introduce another discussion on "Deviation from the Normal Course of Sexual Reproduction in Plants," on which Dr. K. Blackburn and Dr. M. Knight also will speak. Recent work has shown that apogamy is of such common occurrence in the plant kingdom that it is time again to take stock of the position.

Most branches of botany will be well represented in other parts of the programme, including physiology, genetics, cytology, plant pathology, morphology, palæobotany and systematic botany.

The popular lecture this year will be given by Dr. D. H. Scott, who will take as his subject "The Transformations of the Plant World in Geological Time." A full programme of excursions has been arranged.

SECTION L (EDUCATIONAL SCIENCE).

On August 27 Section L (Education) opens its annual meeting under the presidency of Dr. W. W. Vaughan, headmaster of Rugby, with a discussion on "The Training of Teachers." Although inspired by the recent Government report, the discussion is expected to include the training of teachers for secondary schools as well as that for elementary school teachers.

Public attention is to be directed to those conditions of boarding-school dietary (institutional feeding), which experience has shown to be necessary for the health of the growing child. It is hoped to arouse general interest in the need for more careful attention to the many factors involved other than those of cost and calorific value of foods.

The disciplinary value of subjects taught in schools is to form the theme of a discussion immediately following the president's address on "The Warp and Woof of Education." Later on in the session a strong attack is to be made on those schemes of school science that do not include the study of living things; the biologist and zoologists are combining to represent the urgent need of a broader basis for science teaching than exists in the majority of schools,

in the circuit or whether it merely serve to attract and hold the determinant, together with the substances the interaction of which it determines. Taking the case of hydrogen and oxygen interacting at a platinum surface, it is open to question whether the platinum be coupled with both gases at adjacent points, the determinant acting as an electrolytic conductor between the two; or whether the determinant be merely adherent to and concentrated upon the platinum, the two gases being attracted to it: thus forming the circuit within which change takes place.

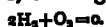
The balance of evidence would seem to be in favour of the former explanation. Thus, platinum influences the interaction of hydrogen and oxygen but not that of carbonic oxide and oxygen. Carbonic oxide and various hydrocarbon vapours even have a protective and preventive action and *apparently* can displace both oxygen and hydrogen from a platinum surface. It might be that carbonic oxide is also more attracted by the liquid determinant. It is almost impossible to grant that any one of the gases can monopolise the surface. The behaviour of carbonic oxide, in fact, is in many respects peculiar and needs special discussion.

Evidence on the point is, perhaps, to be found in recent observations on the interaction of hydrogen and oxygen in presence of silver and gold (D. L. Chapman, J. E. Ramsbottom and G. G. Trotman, Proc. Roy. Soc. A., 197, 92). Bone and Wheeler have shown that both metals are more active after heating in hydrogen but not if heated in oxygen. Chapman and his fellow-workers show that absorbed oxygen acts as an inhibitor, apparently owing to the formation of a film of metallic oxide, whilst absorbed hydrogen does not appreciably diminish or increase the activity of the metal. They have further found that the two gases interact, even at the laboratory temperature, in the presence of a silver film deposited on the inner surface of the vessel in which they are confined. The explanation of the inhibiting effect of the film of oxide may be that, being strongly alkaline, the film holds the *trace of acid* which normally serves as electrolytic determinant. Whether silver act as the catalyst and determine interaction at ordinary temperatures—because it merely attracts the electrolytic determinant and the two gases to its surface—or because either or both of these is absorbed by it, must apparently be left an open question.

The special activity of catalysts, due to their particulate character, may be ascribed to the influence they exercise in maintaining a high "surface concentration" of the interacting substances. On this account, the primary action exercised by the enzyme takes place during the earlier, in fact, a considerable period, at a linear rate, only as the products of change accumulate and the action is reversed to an appreciable extent or the enzyme is neutralised or lamed by products of change is the rate of change perceptibly diminished. This is well illustrated by curves showing how urea is hydrolysed by urease, according as the product of change, ammonia (which but lames the enzyme, as the action is not sensibly reversible), be allowed to accumulate or be neutralised by an acid too weak to affect the enzyme.

Enzymes have a peculiar and rigidly *selective* activity—it is on this account that they form a special class of catalyst. They, therefore, influence the hydrolysis of specific hydrolytes, there is no reason to regard their hydrolytic influence as exercised in any peculiar manner.

To make the argument clear, it may be well to recapitulate and consider the formation of hydrone from hydrogen and oxygen. Being non-conductors, by my postulate above, these gases cannot interact:



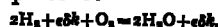
By this same postulate, even the presence of "water" would not suffice:



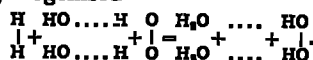
Action would only take place in the presence of an electrolytic determinant.



As, however, the determinant would only be an electrolyte if present as liquid; and moreover, as the formation of liquid appears to be dependent upon the presence of a nucleus, *i.e.* of a surface, it is conceivable that no change would take place unless a catalyst (*k*) were present:



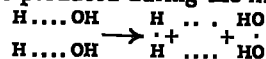
Finally, as interaction takes place in an electrolytic circuit, hydrogen is but indirectly "oxidised" whilst oxygen is hydrogenised



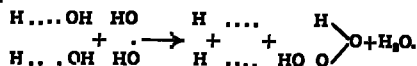
As this illustration shows, oxidation is not a direct but an indirect, *depolarising* effect.

It may be questioned whether water itself, as liquid, should not rank as a catalyst. In the interactions considered, it appears only as part of the electrolytic determinant and is necessarily to be thought of as present in the liquid state. Supposing, however, that in an entirely gaseous mixture—say, under the influence of an electric discharge—a sufficient number of hydrone molecules were temporarily brought into conjunction and formed liquid drops, would these suffice to determine interaction independently of any solid surface? It is possible that they would, if drops were formed under such conditions. The water, however, would not then be acting as catalyst but merely as part of the determinant: the rate of change would not be raised, as it is by solid catalysts.

The argument may be extended to the reverse process—the electrolysis of acidified water between platinum electrodes—and the assumption made that the perhydrone produced during the first stage,



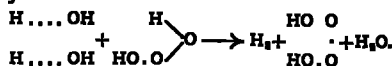
is itself acted upon and hydroxylated during the second:



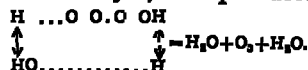
The "oxoperhydrone" thus formed is then hydrolysed into oxygen and hydrone, being itself acted upon, perhaps, as a composite electrolyte.



If the electromotive force or the current density be increased and the rapidity of attack sufficiently raised, the "oxoperhydrone" may be further hydroxylated:



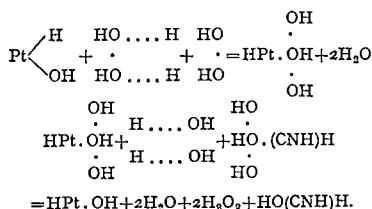
Ozone may be pictured as formed by the hydrolysis of a "dioxoperhydrone" (also, perhaps, in the form of a composite electrolyte) thus produced:



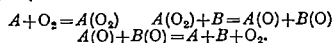
In like manner, when concentrated solutions, particularly of sulphuric acid, are electrolysed, peracids are formed, which, in turn, according to the conditions, give rise to perhydrone, to oxygen or to ozone when hydrolysed.

Oxidation phenomena in general may be interpreted in a similar manner.

The suspended or inhibited oxidations which Moureu and his fellow-workers have studied so thoroughly in recent years, seem to be consistently accounted for by regarding them as involving the continued backward and forward hydroxylation of competing or antagonistic oxidisable compounds—*i.e.* as interference or reversal effects. I have long thought of the inhibition by hydrogen cyanide of the decomposition of perhydrone by platinum or yeast as due to the formation, in the first instance, of perhydrols and their reversible interaction



In result, the interactions here pictured have the same effect as those postulated by Moureu, the main difference being that the process is more clearly defined, as it is represented as "electrolytic" in all its stages. Moureu has usually assumed that the substance primarily concerned is oxidised to a "peroxide," $A(\text{O}_2)$, from which oxygen is transferred to the inhibitor, a second "peroxide," $B(\text{O})$ being formed, the primary "peroxide" being reduced to another "peroxide," $A(\text{O})$: the original molecules are reproduced by the interaction of these antagonistic "peroxides":

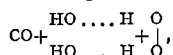


In their recent communication to the Chemical Society, however, Moureu and Dufraisse clearly contemplate the probability that platinum, acting as an oxygen carrier, oxidises the molecules of hydrogen and the interfering gas (H_2 , CO , C_2H_4 , etc.) simultaneously to form two antagonistic peroxides, which then interact, reducing each other.

The oxidation of the two oxidisable substances is and, indeed, must be effected in the same circuit, one of them acting as "depolariser," thereby raising the potential to the necessary extent: otherwise, one would not be oxidised at all or the "antagonism" would be incomplete.

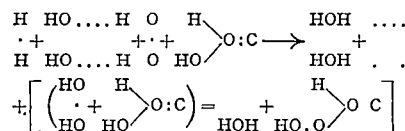
Carbonic oxide may be taken in illustration. I have long wondered at the peculiar behaviour of this gas, in fact since I first read in the early 'seventies Groves' fascinating memoir on his gas battery and Faraday's earlier more complete observations on the combining power of platinum; in the former it is shown that carbonic oxide cannot be coupled with oxygen, as hydrogen can, to form a gas battery. Then came H. B. Dixon's discovery of the incombustibility of the dry gas and the increase in velocity of the explosive wave as the proportion of steam present was raised up to a certain maximum. I have more than once discussed the problem, particularly in 1904, in a brief communication to the Royal Society on "The Retardation of Combustion by Oxygen" (*Proc. Roy. Soc.*, 74, 86), in which I dealt with H. B. Dixon's observations on the retardation of the combustion of hydrogen by "excess" of oxygen and of Bone and Stocking's similar observations on ethane.

Accepting the postulate at the root of the argument in this essay, inasmuch as the oxidation of carbonic oxide is a process involving the electrolysis of water,

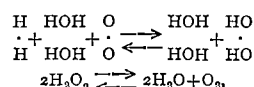


action should not take place at a platinum surface, at

ordinary temperatures, because the heat of oxidation of carbonic oxide is below that of hydrogen: the change would be endothermic. Probably, the combustion of carbonic oxide is never a direct effect but is determined by a minute quantity of hydrogen, acting as adjuvant, produced initially when the combustible mixture is inflamed or sparked:



To repeat what I said in 1904, "It is necessary to remember, that whereas both oxygen and water molecules diminish in stability as the temperature rises, the stability of hydrogen peroxide must be at a maximum at a high temperature—since its formation from oxygen and water is an endothermic process. In fact, it is to be supposed that water is readily oxidised at temperatures such as prevail in combustions. If, however, the formation of water be regarded as involving the changes



it follows that water and oxygen will mutually hold each other in check: so that when electrolytic gas is exploded there will be a deficiency of oxygen; as it were, owing to its conversion into hydrogen peroxide, which may be regarded as relatively if not entirely inoperative as an oxidising agent, at high temperatures, in presence of oxygen. On the other hand, when excess of oxygen is present, the water—which is the effective catalyst—will be more or less held back, also in consequence of its oxidation to hydrogen peroxide."

Whether or no the changes pictured above could equally well take place at a cold platinum surface would be open to question, were it not that platinum is known to determine the interaction of hydrogen and oxygen. There is no reason to suppose that carbonic oxide could not enter the circuit of change, as a depolariser, under such conditions. The difference in behaviour at low and high temperatures is, therefore, probably the consequence of differences in the stability of some of the compounds concerned.

As to the form in which carbonic oxide primarily enters into the circuit of change, it is not unlikely

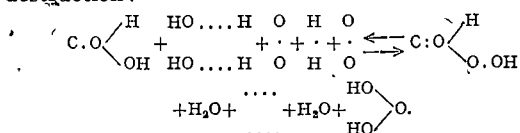
that it is as the hydrol $\text{C}:\text{O} \begin{array}{c} \text{H} \\ \vdots \\ \text{OH} \end{array}$ rather than as

formic acid. Obviously, such a compound would be of low stability and the need of a high proportion of steam, to secure the combustion of carbonic oxide at the maximum rate, may be accounted for by the assumption that the presence of this hydrol, in sufficient proportion, is only to be secured in this way.

The immediate product of the hydroxylation of the hydrol, $\text{C}:\text{O} \begin{array}{c} \text{H} \\ \vdots \\ \text{OH} \end{array}$, would be the "perhydrol"

$\text{C}:\text{O} \begin{array}{c} \text{H} \\ \vdots \\ \text{OH} \end{array}$, a still less stable compound. At ordinary temperatures, at a platinum surface immersed in an atmosphere of hydrogen, carbonic oxide and hydrone, this perhydrol would be antagonised by a corresponding "hydroxyperhydrone" or "oxoperhydrol" and

the two would interact reversibly to their mutual destruction:



At high temperatures, such perhydrols would no longer be formed and the direct combustion of the carbonic oxide with the aid of hydrogen, acting as depolariser, would be effected without their interference and with special readiness.

One other case of apparently anomalous protection against oxidation may be referred to—that afforded by so-called rustless steel and the more recently introduced soft alloy staybrite. The former is a chromium steel, the latter an alloy of iron, nickel and chromium, as free as possible from impurities. That chromic acid will protect iron against oxidation is well known. It may be supposed that, in an alloy of iron with chromium, in which the chromium is properly distributed, both materials undergo surface oxidation to perhydrols, which act reversibly, so that at most a layer of molecular thickness is affected, a coating being formed which may well correspond with the (?) unimolecular layer of oxide upon the surface of the far more sensitive metal aluminium.

It is permissible to suggest that the influence of certain dyestuffs in checking the "fogging" of an undeveloped photographic plate may perhaps be traceable to the initial production of antagonistic perhydrols by simultaneous hydroxylation of the sensitive film and the coloured material.

Finally, some reference to the oxidases may not be out of place. These are commonly spoken of as enzymes but they are in no way comparable with

these, in so far as they act selectively. They are only selective in the broad sense, that they are effective agents in determining the oxidation of compounds of a particular general type. Thus so-called tyrosinase will determine the oxidation of phenolic compounds of a certain type—not of tyrosin alone. This is true of "oxidising" organisms, such as *Bacterium aceti* and *B. xylinum*. The behaviour of *B. aceti* is altogether peculiar—although active towards ethylic and normal propylic alcohols, it has no action upon either methylic or isopropylic alcohol. At present we know so little of the process at work that it is impossible to attempt any precise explanation of these peculiarities. It may be suggested, however, that they are traceable both to configurational and energy differences in the systems concerned; moreover, it is clear that something more than the simple, direct oxidation of the alcohol is to be contemplated and that cross-interactions may be at work. Maybe we shall have little success in interpreting such actions until we no longer think "on paper" but have clear conceptions of the solid configuration of molecules. The oxidases may well be discarded from the class of enzymes and regarded as simple catalysts—of a parity with platinum black.

Not a few mysterious processes may be open to interpretation in accordance with the principle developed in this essay. The peculiar behaviour of phosphorus is a case in point—especially the dependence of the appearance of luminosity upon the partial pressure of the oxygen and the phenomena of intermittent luminosity to which Lord Rayleigh has recently directed attention. Little can be said with advantage, however, until we know far more of the several stages of the oxidation process—which may well be as complex as that of the interaction of nitric acid and metals.

Genetical Investigations.

THE practical value of chromosome studies is perhaps nowhere better demonstrated than in the wheats, where the species belonging in different groups have different multiples of 7 as their chromosome number. In hybrids between species with different numbers of chromosomes, the peculiarities in the hybrid behaviour are largely explained by the history of the chromosomes, some of which pair in meiosis while others remain single.

Sax and Gaines¹ draw several conclusions from a study of hybrids between emmer wheats (28 chromosomes) and vulgare wheats (42 chromosomes), which have been grown through several generations. The various segregates tend ultimately to have the same chromosome numbers as the original parents. This is accomplished through sterility or loss of chromosomes in forms with intermediate numbers, as has been found also in the *Enotheras* and in other cases. Segregates with 28 chromosomes resemble the emmer wheats, while those with 42 have most of the vulgare characters. This indicates that the 7 extra pairs of chromosomes determine most of the vulgare characters. The chromosome behaviour would lead to the expectation that ordinary Mendelian segregation would occur in characters, such as presence or absence of awns, yellow or black awns, and red or white grain, which are common to both the emmer and vulgare groups of wheats; while aberrant segregation would occur in regard to characters which distinguish the two groups. This is largely borne out by the

results of experiment. Some of the segregates show combinations of typical emmer and vulgare characters, which indicates that the 7 unpaired chromosomes (which are irregularly distributed in meiosis) independently determine particular characters of the vulgare group.

Another interesting result, obtained by Mr. and Mrs. Sax,² is derived from a cross between *Ægilops cylindrica*, a grass found in Italy, the Balkans, and neighbouring countries, and Marquis wheat, one of the most productive varieties of *Triticum vulgare*. *Ægilops*, like the emmer wheats, is tetraploid, having 28 chromosomes. The F₁ hybrid with *T. vulgare* is pentaploid (35), but unlike the crosses between tetraploid and hexaploid wheats, there are only 6 or 7 bivalents in meiosis (instead of 14), the remaining 21 chromosomes remaining univalent or unpaired. Nevertheless, the tetrad divisions are run through with very few irregularities, some of the univalent chromosomes apparently dividing in the first meiotic division while others divide in the second. The F₁ hybrids are in general intermediate between the parents, and are almost but not completely sterile.

The authors point out that this species of *Ægilops* and another both contain all the characters which distinguish the vulgare from the emmer wheats, and they suggest that the hexaploid vulgare wheats may have arisen through a spontaneous cross between *Ægilops* and a tetraploid (emmer) wheat. Irregular distribution of the unpaired chromosomes, of which there would probably be 14, would occasionally

¹ Sax, Karl, and Gaines, E. F., 1924, "A Genetic and Cytological Study of certain Hybrids of Wheat Species," *Journ. Agric. Research*, 28: 1017-1032, pls. 2.

² Sax, K. and H. J., 1924, "Chromosome Behaviour in a Genus Cross," *Genetics*, 9: 454-464, pls. 2.

produce a gamete with 21 chromosomes. The union of two such gametes, if the chromosomes were balanced in qualities as well as in numbers, might have produced the first of the hexaploid wheats. Thus is crossing combined with chromosome aberrations made the basis for a theory of the origin of our cultivated wheats.

Contributions continue to be made to the study of size inheritance. The prevalent interpretation is that size in organisms and in their parts is controlled by cumulative polymeric size factors the various increments of which give the appearance of a continuous series. Much evidence is appearing in favour of this view. Sax³ has recently, from experiments with beans, found evidence of linkage between certain seed-coat colour patterns and certain factors for size of seed. Cases have even been found in which a factor for large size was contributed by the small parent. Such a result might occur if the small parent contained a few factors for large in addition to a number which made for small size.

Closely related to size-inheritance are the problems of shape. The work with animals indicates that some size factors may affect the body as a whole while others independently determine the size of particular organs. These conceptions have already been applied by Davenport to man, and in a recent contribution⁴ he considers the inheritance of body build. He recognises five classes of build, ranging from very slender to very fleshy. Two slender individuals usually have only slender children, while the progeny of fleshy individuals are much more variable. Such data lead again to the hypothesis of multiple factors, and it is believed that in some families so many as three genetic factors for increasing fleshiness are present. These factors are thought of as influencing size by the effect they have upon the activity of the thyroid, pituitary, and other endocrine glands.

Similar conceptions are being applied by Frets, Hildén, and others to the inheritance of head-shape. Thus it appears that several factors for broader head may change a dolichocephalic to a brachycephalic skull. Thus genetics is destined to have a fundamental effect upon the interpretations of anthropologists.

R. RUGGLES GATES.

The Carbonisation of Coal.

THE Chemical Engineering Group of the Society of Chemical Industry met on July 16 at the forty-fourth annual meeting of the Society at Leeds. Three important papers on features of coal carbonisation were read before a crowded audience, and the discussion had to be adjourned to another session proposed to be held in Leeds in the autumn. Solid fuels were dealt with in two papers: "Smokeless Fuels—the Present and Future Possibilities," by C. H. Lander and Margaret Fishenden, and "Solid Smokeless Fuels," by E. C. Evans. In the former paper the British fuel situation was analysed, particularly with the view of estimating the possibility of establishing new carbonising industries. If all coal were to be pre-carbonised, the disposal of gas and tar would become considerable problems. If domestic fuel only were to be carbonised, this difficulty would be much less, but it was considered that a coke of much more suitable character than that currently produced in gas works would be required. The domestic fuel market is the most promising outlet for carbonised

fuel of suitable character. It was concluded that the most suitable carbonisation process to meet this need cannot be defined with certainty. The solution of the problem may prove to be not in any single method of carbonisation but in several, each operating in circumstances most favourable to its requirements.

E. C. Evans gave a classification of smokeless fuels, directing attention to the properties of anthracite, for which there is a steady demand even to-day, in spite of its high price. This points a moral to those desirous of introducing carbonised domestic fuel. Gas coke he considered as far short of the ideal, particularly because of its high ash and moisture content. The reactivity of coke was treated at length, and the factors influencing it were analysed. Methods of low temperature carbonisation were discussed. In summing up, Evans thinks that low and high temperature systems are approaching one another, and that ultimately a compromise will establish itself. In the discussion it was significant that, in so representative an assembly of fuel technologists, no one could be found to assert confidently the commercial feasibility of existing methods of low temperature carbonisation which figures so prominently in the Press and on the platform.

F. S. Sinnatt and J. G. King brought forward a study of the tars and oils from coal. From an analysis of the economics of mineral oils and coal tars, they drew the conclusion that the prices obtainable for low temperature tars would, so far as present promise goes, be low and liable to great fluctuation. The calorific value of such tar is low, and the difficult miscibility with mineral fuel oil is a limitation. This is not necessarily fatal, for the Lessing process for separating the pitch-giving constituents, now under trial at the Fuel Research Station, shows considerable promise. Some account of these results was given. The limited knowledge of the chemistry of low temperature tar was emphasised, and it was suggested that organic chemists should take up the study of its properties. The production of liquid fuel from coal, either by hydrogenation of the coal or of the gasified product, was also discussed.

University and Educational Intelligence.

"INFORMATION regarding courses and careers open to students of science" proposing to enter the Faculty of Science of the University College, Cardiff, is given in a little pamphlet issued this year for the first time by the College authorities. It follows the lines of the similar pamphlet issued by the University of Birmingham last year and represents a commendable anxiety on the part of the College to acquaint parents, guardians, and heads of schools with the opportunities it offers, so that the last year or two at school of those intending to go on to college may be utilised to the best advantage.

FROM the Royal Technical College, Glasgow, and the Merchant Venturers' Technical College, Bristol, we have received prospectuses for 1925-26. The former, which is the only institution in Great Britain providing regular courses in the technology of sugar manufacture, announces that to meet the requirements of the beet sugar industry, the lectures in this subject will begin in January and will extend over the summer session. Both Colleges give lists of the engineering firms which offer facilities to students for acquiring practical experience in their works. The Merchant Venturers' College offer, as alternative courses for the degree of B.Sc. in engineering, a

³ Sax, K, 1924, "The Nature of Size Inheritance," *Proc. Nat. Acad. Sci.*, 10, 224-227.

⁴ Davenport, C. B., 1925, "Body-build: its Development and Inheritance," *Eugenics Record Office, Bull. No. 24*, pp 42, figs. 25.

continuous 3-years' course, a 5-years' course of evening class work, and the Bristol sandwich system, which interposes practical training in a works for 14 months between the first and second sessions of academic work, for two summer months between the second and third sessions, and finishes with practical work for 14 months after the third session. Loughborough College, on the other hand, claims in its Calendar for 1925-26 to have found a better way of training by providing facilities for all necessary practical work in its own workshops, so that the theoretical work in the College may be made to keep step with the workshop training.

HONOURS courses in American universities and colleges are described by President Aydelotte of Swarthmore College, Pennsylvania, in a report recently published (Bulletin No. 52 of April 1925) by the National Research Council of America. So vigorous is the movement in the United States for liberalising higher education by the introduction of honours courses more or less like those open to students in English universities, that the number of institutions offering such honours work has doubled since the publication in January 1924 of the first edition of this report, when the number was about 46. The character of the movement is determined by the recognition of two principles which are regarded as the foundation of the success of the English honours system: the frank distinction between students who are really interested in the intellectual life and those who are not, and the recognition of the necessity of allowing the former more responsibility for working out their own intellectual salvation. President Aydelotte is careful to point out in concluding his report that "the system now being introduced need not mean any curtailment of the quality of teaching enjoyed by the average student. What our best students need is not coddling, not more attention, not more teaching, but only greater freedom and more severe requirements."

In the report for the session 1923-24 of the Department of Coal Gas and Fuel Industries of the University of Leeds, the Livesey professor remarks that whilst the Department is developing satisfactorily so far as post-graduate work is concerned, the supply of students taking the normal three or four years' course of training in fuel, leading to a degree or diploma granted by the University, is inadequate to meet the demands of the fuel industries for trained fuel technologists. The University requires a steady supply of students, whose numbers may be depended upon from year to year, rather than any large increase in their number. Laboratory facilities at the disposal of the Department are at present inadequate to enable students of mechanical, civil, and electrical engineering to obtain desirable training in fuel technology and metallurgy. Through the generosity of Mr. Henry Woodall, and a number of gas companies and other industrial concerns, an experimental coal gas plant has been presented to the University, and has been employed in work carried out for the Gas Investigation Committee of the University and the Institution of Gas Engineers. Research work carried out in the Department relates to the influence of ash constituents in coal on the carbonisation process; the scaling of metals; the hardness of metals as affected by grain size; the transformation of quartz during the process of manufacture of silica bricks; metallic coatings resistant to oxidation at high temperatures; gas purification; the thermal expansion of metals and alloys and the changes occurring on heating clays, bauxites, etc.; the aeration of gas jets, and heat recovery by waste-heat boilers

Early Science at Oxford.

August 26, 1684. Dr. Plot, lately come from ye Royall Society, informes us, that in a meeting of that Society, on some day in this month, he saw a handkercheif, made of Salamanders Wool, or *Linum Asbesti*, shewn ye Royall Society by a merchant, who lately brought it from China. To try whether it was genuin, or no, it was put into a strong charcoal fire; in which not being injured, it was taken out, oiled, and put in again; ye oil being burnt off, the handkercheif was taken out again, and was altered onely in two respects; it lost two drachms and five grains of its weight, and was (as ye merchant affirmed) more brittle then ordinary; for which reason, it was not handled untill it was grown cold, by which time it had recovered its former tenacity, and in a great measure its weight.

The merchant, who oblidged ye Society with ye sight of so great a Rarity, acquainted them, that he received it from a Tartar, who told him, that the Tartars, among whom this sort of cloth is sold at £80 sterling for a China Ell, (which is less than our Ell,) use this cloth in burning ye bodyes (to preserve ye ashes) of great persons, and that in Tartary it is said to be made of ye root of a tree. The thread of it was (as ye Doctor affirms) very large.

He also acquainted us, that it haveing formerly been queried in ye Royal Society in London, whether ye Air contained in ye spirit within a thermometer, be not some cause of the ascent of that spirit in hot weather.

This quære was resolv'd by ye following experiment: a little Siphon was made to reach from ye top of the thermometer, to the receiver of Mr. Boyl's pump; ye air in the thermometer was drawn out, after which a warm hand being applied to it ye spirit did *still* rise.

The observations of Mr. Bullialdus, Mr. Cassini, and Mr. Jacobs at Lisbon concerning ye last solar Eclipse, were presented our Society, and compared with those made here at Oxon.; and at Greenwich.

Mr. Boyle's booke of ye Porosity of Bodyes was communicated to our Society.

A Letter from Mr. Robert Spear to Dr. Wallis, dated from Port Royall in Jamaica, May 10, 1684, was read; it mention'd a Booke lately printed at Boston, in New England, entituled *An Essay for the Recording of Illustrious Providences*; in which, among other relations, there is an account of ye poles of some needles of Sea-compasses being burn'd by thunder, and lightning, near New England; it is almost verbatim with the account of the same thing mention'd in ye Philosophical Transactions no: 157.

Dr. Plot shewed us some of ye *Risagone Ind.*; or Cassumminiar, a root found on ye mountains 24 gr. Lat: about Patmia near Bengal. Snow will not lye over it long; 'tis of very thin parts, bound up in an earthy matter; us'd in many diseases of ye head and nerves, and in dysenteries; being ground to powder, and given in common water; a decoction of it is made in ye same manner as coffee.

The Doctor tells us, as he is inform'd by good hands, that Mr. Hugh Percy of Weymouth has enquired into ye nature of ye current at ye Straights mouth, by letting fall a bucket, and a weight with it, and that he found his bucket constantly carried outwards; it is to be wished that Mr. Percy be desired to give his own account of what he has done in this kind.

September 2, 1684. There being no great appearance of company, all business was deferred to some fuller meeting.

Societies and Academies.

CALCUTTA.

Asiatic Society of Bengal, July 6.—Braja Lal Mukherjee: The Vratyas and their sacrifices. Vratyastoma is a social or religious penance for those who have in some manner or other defied or neglected religious law and order. Men originally belonging to the Vaidik community, but becoming alienated, and neglecting or defying Vaidik precepts, and creating disorder, were called Vratyas.—Bimala Charan Law: Data from the Sumangalavilāsini. An attempt has been made to present from the Sumangalavilāsini (the commentary on the Dīgha Nikāya of the Sutta Piṭaka, written by Buddhaghosa), interesting materials for the study of ancient Indian life.

SYDNEY.

Linnean Society of New South Wales, May 27.—May M. Williams: Contribution to the cytology and phylogeny of the siphonaceous Algæ. (1.) The cytology of the gametangia of *Codium tomentosum*. In the nuclear divisions occurring in the cœnocyctic threads of the vegetative parts of the plant, twenty univalent chromosomes are present. Reduction division occurs in the gametangium as the result of two nuclear divisions which occur there. Certain of the nuclei present in the young gametangium degenerate before these divisions occur. The selection of functional nuclei is associated with the presence of bodies of the nature of cœnocentra within the gametangium.—H. Burrell: Burrowing habits of *Ornithorhynchus*. A Platypus (usually the female), in excavating its burrow, will, if necessary, lie on its back to work. Its muscular and mobile movements are described, particularly with reference to the work of the hind feet, which have a "two-way" action, and are as versatile as those of a chimpanzee. The functions of the hind and front legs are interchangeable.—J. R. Malloch: Notes on Australian Diptera. No. vi.—G. D. Osborne: Geology and petrography of the Clarencetown-Paterson District. Part iv. The petrographical account of the Kuttung igneous rocks is divided into (a) a general discussion of such matters as the sequence of flows and their mutual relationships, and the presence of devitrification, of spherulitic structures, and in particular of evidence which has been interpreted as indicative of the operation in some rocks, after consolidation, of processes connected with the magmas from which these rocks were derived; (b) a petrographical description of the rocks, taken in groups.

Royal Society of New South Wales, July 1.—H. Leighton Kesteven: (1) A third contribution on the homologies of the parasphenoid, ectopterygoid, and pterygoid bones, and of the metapterygoid. (2) The parabasal canal and the nerve foramina and canals in the bird skull. The application of Gaupp's designation "parabasal" to the carotid canal and the demonstration of the course of the palatine branch of the facial nerve serve to emphasise resemblances to the reptilian conditions.—A. R. Penfold: Note on the identity of uncineol with eudesmol. Uncineol ($C_{10}H_{18}O$, $[a]_D^{20} +36.99^\circ$; melting-point, $72.5^\circ C.$) is an alcohol which appears to bear a close resemblance to one of the terpineols, isolated in 1907 by Messrs Baker and Smith from the essential oil of *Melaleuca uncinata*. The more recent investigation has shown this substance to be identical with the sesquiterpene alcohol eudesmol. The chemical and physical characters are: Melting-point, $80.5-81^\circ C.$; boiling-point, $155-156^\circ C.$ at 10 mm.; specific rotation, $+33.45^\circ$; molecular weight deter-

minations, 221 and 227; molecular formula (combustion results), $C_{15}H_{26}O$; melting-point of dihydrochloride, $75-76^\circ C.$ —Sir George Knibbs: Multiple births, their characteristics and laws mathematically considered. Considering the question of masculinity of population generally, of live-births, and of the still-born, it is shown that the preponderance of males is most marked in the last, being about 21.9 per cent. greater than that of live-births. In Australia, as the masculinity of the general population decreases, that of the live-births increases. Applying the theory of probability to the occurrence of twins, about 76 per cent of the cases are from two ova, and about 24 per cent. from one ovum. In the latter case the pair may be either both male or both female, and have a common chorion, while twins born from two ova are indifferently male and female, two males, or two females, and each has its separate chorion. Only about 10.9 per cent. of triplets are from three ova, while in 69.1 per cent. there is a division of one of the ova into two. There is an increase of the liability of twins with the age of the mother each year from 12 years to 39 years, when it diminishes, nearly by the same amount each year of age, until it becomes nothing at age 54. This greater liability with age to twins increases with the duration of marriage and with the number of previous confinements.

Diary of Societies.

WEDNESDAY, AUGUST 26.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 8.30 P.M.—Prof. H. Lamb: Presidential Address.

THURSDAY, AUGUST 27.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 10 A.M.—Prof. W. A. Parks: The Cultural Aspects in Geology (Presidential Address to Section C).—Sir Arold Denny: Fifty Years' Evolution in Naval Architecture and Marine Engineering (Presidential Address to Section G).—Prof. J. Spearman: Mental Law of Diminishing Returns (Presidential Address to Section J).—Prof. J. Lloyd Williams: The Phycophyceæ and their Problems (Presidential Address to Section K).—At 11.30 A.M.—A. R. Hinks: The Science and Art of Map-making (Presidential Address to Section E).—At 2.—Conference of Delegates of Corresponding Societies.—Address by Sir Daniel Hall, President of the Conference.—At 7.30.—Major A. G. Church: Science and the East African Commission (Citizens' Lecture).

FRIDAY, AUGUST 28.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 10 A.M.—Dr G. C. Simpson: The New Idea in Meteorology (Presidential Address to Section A).—C. Tate Regan: Organic Evolution: Facts and Theories (Presidential Address to Section D).—Dr. W. W. Vaughan: The Warp and the Woof in Education (Presidential Address to Section L).—At 11 A.M.—Miss Lynda Grier: The Meaning of Wages (Presidential Address to Section F).—At 11.30 A.M.—Dr. T. Ashby: Practical Engineering in Ancient Rome (Presidential Address to Section H).—At 2.30 (Section I).—J. B. Barnard: The Observation of the Infinitesimally Small (Lecture).—At 8 P.M.—A. V. Southwell: Aeronautical Problems of the Past and of the Future (Discourse).

SATURDAY, AUGUST 29.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 8.—Dr. F. A. Dixey: Munier in relation to Geographical Distribution (Lecture for Young People).—At 8.—Prof. E. V. Appleton: The Role of the Atmosphere in Wireless Telegraphy (Citizens' Lecture).

MONDAY, AUGUST 31.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 10 A.M.—Prof. C. H. Desch: The Chemistry of Solids (Presidential Address to Section B).—Prof. A. V. Hill: The Physiological Basis of Athletic Records (Presidential Address to Section I).—Dr. J. B. Orr: The Inorganic Elements in Animal Nutrition (Presidential Address to Section M).—At 3.—W. H. Barker: The Development of Southampton in relation to World Commerce (Lecture for Young People).—At 5 (Section K).—Dr. D. H. Scott: Some Points in the Geological History of Plants (Lecture).—At 8.—Capt. P. P. Eckersley: Some Technical Problems of Broadcasting (Citizens' Lecture).

TUESDAY, SEPTEMBER 1.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 3.—Prof. W. J. Dakin: Whaling in the Southern Ocean (Lecture for Young People).—At 8.—C. J. P. Cave: The Highway of the Air (Citizens' Lecture).

WEDNESDAY, SEPTEMBER 2.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton),



SATURDAY, AUGUST 29, 1925.

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The Coal Resources of Great Britain.

TO all sections of the community, the state of the coal mining industry in Great Britain is a source of great anxiety. The real difficulties which the industry has to face depend upon causes which are very deeply rooted. We were the first nation to develop our coal resources extensively and, owing to the fact that we had originally magnificent coal seams lying at no great depths, and above all, that our coal-fields lay close to the seaboard and within easy access of excellent harbours, we built up the magnificent coal trade upon which we justly pride ourselves. Coal, our main national asset, is unfortunately a wasting asset; once extracted it can never be replaced. At the present moment we are practically producing 23 per cent. of the world's coal output, whilst we have only $2\frac{1}{2}$ per cent. of the world's coal resources; in other words, we are drawing upon our coal reserves nine times as fast as the rest of the world, and these reserves are therefore gradually approaching extinction.

At the present moment, however, what we have to fear is not the exhaustion of our coal supplies so much as the increased cost of our coal production, which makes it impossible for us to compete with other nations for the coal trade of the world. This increase in price is no doubt to some extent due to natural causes, but to a far greater extent has been brought about artificially. Unless we can produce coal as cheaply as the nations with whom we are brought into competition, our coal trade, and with it the whole nation, must decline. The cost of coal production is made up of many items, into all of which wages enter to a greater or lesser extent, but direct wages make up about two-thirds of that cost. It depends, therefore, entirely upon labour whether our coal trade is to prosper or to suffer gradual annihilation. It must be emphasised in the strongest possible terms that this insistent demand for cheap production does not by any means necessarily imply low wages per man employed; it does require a low wages cost per ton of coal produced; in other words, the key to the situation lies in the maximum production per worker engaged in the industry.

In the United States of America, the cost of coal production is roughly two-thirds of what it is in Great Britain (12s. 8.4d. per ton as against 19s. 0.69d.); nevertheless, the men engaged earn much better wages, simply because the output per man is so much higher (3.82 tons per shift as against 0.928 ton). This fact is due in part beyond doubt to natural causes, but is also due to the fact that the men themselves work hard and that the Trade Unions have always opposed anything like a "ca' canny" policy. These same reasons furthermore help American collieries to develop extensively mechanical methods of machine mining. It is often overlooked that a severe limitation of the hours of labour, such as we have in Britain, prevents the extensive adoption of coal-cutting machines; these can only be used to advantage if they are kept actively employed. A colliery cannot afford to put capital into such machines if they are only to be worked six hours out of the twenty-four, and this consideration doubly handicaps our coal industry.

When the future of the industry comes to be considered, it may well be found that neither American nor German competition will prove so formidable as competition from China, India, and South Africa. The price of coal at the pit's mouth in these countries is only about one-third of our own, and their immense coal resources necessarily bring them into prominence in discussing the future of the British coal industry. It is true that we have the advantage of a well-established coal trade, which has developed as a natural consequence of so many of the British coalfields being so well situated geographically, and it is true that trade is loth to leave the channels in which it has been accustomed to flow. Certain of our labour leaders, however, by their continuously repeated threats of strikes, are demolishing that confidence in Britain's ability to supply the goods as and when customers require them, which formed the real basis of Britain's supremacy in the coal trade, and without which the maintenance of that trade is impossible. Once that South Africa has developed and organised suitable transport facilities and has built up for itself the trade which our internal dissensions have turned from us, our chance of competing is gone. Even now it is going; for some years past Natal has been competing successfully in the Bombay markets with British and Indian coals.

It seems impossible to avoid the conclusion that we cannot hope to regain the position which we once held, that of the world's chief manufacturers, as this was based essentially upon the fact that we were able to produce coal in any desired quantity more cheaply than could any of our competitors, and the question which to-day is the most insistent is whether anything can be done, if not to restore our lost supremacy, at any rate to find some new method of utilising our coal to advantage, so as to save us from national extinction.

The situation is reviewed in an interesting article by Mr. Lancelot Lawton on "Coal and the Future" in the August issue of the *Fortnightly Review*. With most of the views therein expressed the majority of serious students of the economics of the coal industry will cordially agree, although there are several points to which exception may be taken. Thus the author commences with the statement that "the critical condition of the British coal-mining industry is due to the fact that to a large extent thicker seams at moderate depths are being exhausted"; the fact of this exhaustion is sufficiently well known, but working at moderate and even considerable depths is to-day no longer a serious problem. With modern methods of engineering, the increase in the working cost of winning coal from deep-lying seams is negligible, as witness the fact that the only collieries in Britain that are working to-day under anything like satisfactory conditions are the deep pits in the concealed Yorkshire coalfield. The real crux in the working of deep seams lies in the vastly greater initial outlay required, but, once capital can be assured that it will get an adequate return for its employment in such a relatively risky undertaking, depths of even of a thousand yards can no longer be considered a real obstacle to economic working. It may fairly be said that in spite of the wild talk of Socialists, one of the serious problems that

confronts the coal industry is how to inspire capitalists with this assurance; collieries inevitably become exhausted in the process of time, and if our coal trade is to be maintained, new pits must be sunk and new collieries opened out. Needless to say, this can only be done if the capitalist is assured that the investment involves only a fair business risk.

Like many others, Mr. Lawton pins his faith in the regeneration of the coal industry upon the general employment of low temperature carbonisation, with its attendant production of oil and other bye-products. Low temperature carbonisation is, however, by no means yet as assured of success as many seem to think, for they generally overlook not only the mechanical difficulties, but also the chemical difficulties which the process presents, such as are well indicated in the paper on the "Study of the Tars and Oils obtained from Coal," by Messrs. Sinnatt and King, read at Leeds at the recent meeting of the Chemical Engineering Group of the Society of Chemical Industry. Furthermore, there are other processes to be taken into account; it may fairly be said that for the production of oil from coal the Bergius process would seem to promise to rival, if not to surpass, low temperature carbonisation; the "Synthol process," based upon the interaction between carbonic oxide and hydrogen, also must not be left out of account, although this is not an industrial process to-day. Fischer, in his recent work on the conversion of coal into oil, translated by Lessing, says: "The Synthol Process, combined with primary tar production, likewise indicates the possibility of a total conversion, and indeed offers, in my opinion, the best promise for the future."

In view of these and many other possibilities which the scientific research of coal, now actively pursued in many quarters, is opening up, it is more than doubtful whether it would be a wise policy to-day to embark upon the construction of costly low-temperature carbonisation plants. A few years may well see this process relegated to the background and displaced by some more profitable method.

Capitalists are surely wise in waiting to see which process is likely to be the most advantageous before spending money on plants, which, for all we know to-day, in a few years may have only a scrap-iron value.

It is greatly to be feared that any remedy based upon the treatment of coal after it is won would not help the situation. As Mr. Lawton truly enough points out, any improvements in the utilisation of coal cannot possibly be confined to Britain, but will be universally adopted by other nations engaged in coal production, so that we necessarily come back to the economic proposition that the future of coal rests with those nations that can produce it cheaply. There is, in fact, only one remedy for the present critical position of the British coal industry, and that is the cheaper production of coal, which, as already said, means a greater output per man employed in the industry. A colliery that is unable to produce coal at a price less than the coal is worth in the world's markets is not a national asset but a national liability so long as it continues to work, and no method of treating the coal after it has been raised can possibly alter that cardinal fact.

HENRY LOUIS.

Science on Exhibition.

Phases of Modern Science. Published in connexion with the Science Exhibit arranged by a Committee of the Royal Society in the Pavilion of His Majesty's Government at the British Empire Exhibition, 1925. Pp. vii + 232. (London: A. and F. Denny, Ltd., 1925.) 3s. 6d.

THAT a space should have been set aside for scientific exhibits at the British Empire Exhibition is a compliment, well deserved but not the less welcome, to the progress of modern science. That the task of filling this space should fall upon the Royal Society was inevitable, and it would certainly be difficult to conceive, and impossible to convene, a stronger committee than that appointed by the Society for the purpose. The volume which we have before us, with the title "*Phases of Modern Science*," contains a record of its second and revised version of a scientific exhibition. The actual guide to the exhibits occupies the second and smaller portion of the book. The first and larger part consists of articles, by many of our most eminent men of science, dealing, more or less directly, with the subjects which the exhibits are intended to illustrate. Chemistry is not dealt with, the exhibits in this branch of science having been arranged by the Association of British Chemical Manufacturers in the Palace of Industry.

There is a notion current that scientific workers are shockingly bad showmen. They are accused of being in possession of all kinds of fascinating secrets which they are either unwilling or more probably incompetent to communicate. They are supposed, through some defect in their education, to be unable to speak in language understood by the people, and from time to time journalists have attempted to translate this scientific jargon into their own, with results which have not always been happy. We think that a careful study of the articles in this volume should convince any unprejudiced reader that the accusation is without any real basis. It is difficult to imagine how the present state of our knowledge of radiation, for example, could be expressed more simply and, we may add, more delightfully than in Sir Oliver Lodge's introductory article on "*Radiation*," or how recent advances in astronomy, made as they were by a masterly combination of physical imagination and mathematical analysis, could be conveyed more happily than in Prof. Eddington's article on "*The Interior of a Star*." If it is not invidious to pick out one article when so many are good, this contribution of Prof. Eddington, which is abstracted from a Royal Institution discourse, strikes us as a model of popular scientific exposition. Sir Ernest Rutherford on "*Electricity and Matter*,"

and Dr. Aston on "*Atoms and Isotopes*," are almost equally successful.

It is not, of course, to be assumed that these articles can be followed entirely without effort by a reader devoid of scientific knowledge. The temple of science is, unfortunately, not furnished with lifts, and whosoever would ascend to the upper stories, where building is in progress, must be prepared to do a little climbing, however skilful his guide may be. The phases of modern science dealt with in this volume are the culmination of many years of scientific discovery and research, and some knowledge of this preliminary work is necessary, not merely for understanding but even for enjoyment. The delight of the spectators when a conjurer produces a rabbit from a top-hat is founded on their previous knowledge of the natural history of top-hats and rabbits, and the thrill which the scientific world experienced when Sir Ernest Rutherford produced hydrogen from nitrogen is similarly based on some previous knowledge of the chemistry of these substances, and is not to be achieved by one to whom both hydrogen and nitrogen are equally unknown. It is to such inherent difficulties, and not to any lack of showmanship, that we must ascribe the hiatus which we all deplore between the scientific worker and the public.

All parts of science do not present equal difficulties, and, it must be confessed, all eminent men of science do not possess the same facility for popular exposition. In the "*Circulation of the Atmosphere*," and in the "*Water in the Atmosphere*," Sir Napier Shaw and Dr. G. C. Simpson have subjects which appeal to the man in the street, ever interested in that perennial source of conversation, the weather, and deal with them in a way which will appeal not only to the general reader but also to the scientific worker who has not hitherto chanced to stray down the interesting by-path of meteorology. Prof. Fowler, on the other hand, in the "*Origin of Spectra*," and Dr. Chree in "*Atmospheric Electricity*," are clearly writing for students of science, and make no attempt to reach the uninitiated. Both articles are good of their kind, and Dr. Chree's, in particular, is a valuable summary of facts and phenomena which the physicist does not usually stumble across in his ordinary reading.

Of the biological articles, which occupy a somewhat unduly small space in the volume, the majority deal more or less directly with the theory of evolution and natural selection. The conclusions drawn are not such as would commend themselves to the stalwart "*Fundamentalists*" of Tennessee. In this portion of the book the present reviewer can claim to be in the position of the general reader, and can testify from personal experience that, though he can understand the complaints

which are lodged sometimes at too free a use of technical language by scientific writers, these biologists have certainly succeeded in "getting their ideas across." His only regret is that they do not fill a larger space in the bill. There are, however, strict limits to the amount of printed matter which can be sold at the modest price of this volume.

Of the exhibits themselves it may be said, in conclusion, that they prove that to his own peculiar audience, the man of science can be an incomparably fine showman. The fact that the exhibits are confined almost wholly to the more recent developments of science makes it inevitable that their principal appeal should be to the serious student of science. To the younger students, and particularly to those from the smaller seats of learning, somewhat remote from the larger institutions where the tide of research flows at its fullest, this collection has been a source of inspiration and delight. By them, at any rate, this little volume will be cherished as a memento of a memorable event, while many others may find in its introductory articles a pleasant and convenient means of learning, on the best authority, the present position of knowledge and conjecture in phases of modern science which are not peculiarly their own.

The Realm of Plants.

Plants and Man: a Series of Essays relating to the Botany of Ordinary Life. By Prof. F. O. Bower. Pp. xii+365. (London: Macmillan and Co., Ltd., 1925.) 14s. net.

IF an extra-terrestrial observer, gifted with super-human powers of ocular accommodation and unhampered by human prejudices as to man's position in the scheme of things, were given the opportunity of surveying with detachment the myriad-patterned pellicle of life that invests the earth, the function of the human species might afford him material for confusing speculation. As he gazed on some parts of the planet he might be driven to entertain an Erewhonian conception of man's relation to machinery, but, surveying the greater part of the land surface, he might well be excused for concluding that man's chief function was the distribution of certain dominant species of plants, for he would see almost everywhere men toiling to spread the triumphant grasses and a host of other less dominant but still powerful green organisms. In this view of man's relation to plants, our extra-planetary philosopher would not be without a certain amount of human concurrence, for to a large section of humanity a seductive species of *Rosaceæ* represents the primal cause of man's introduction to that distasteful (?) form of activity known as work.

Although in his latest book Prof. Bower has not expounded the polity of plants from quite such a Saturnian point of view, both the order of its title, "Plants and Man," and the presentation of its matter, are not without a tincture of such significance. His theme is the mutual reactions of plants and man, skilfully leading on to the final vision of the fundamental dependence of man on his fellow-creatures the plants for all that he has become and yet may be. It is impossible within the compass of a review to give an adequate idea of the multifarious relations between plants and man so succinctly and clearly presented in the thirty essays that form the book, and an attempt at a general indication of its contents must suffice. The first five essays are devoted to the green cell that tints the continents and islands, and is the foundation of all life thereon and in the sea, and to the general scheme of construction and the vital processes of the complicated commonwealth of cells that forms plants. The influence of the seasons is touched upon in another essay, and after this general introduction the reader is taken in pleasant and suggestive discourse by meadow and pasture, through woodland, over moor and mountain, and along the shore.

From these varied and extensive excursions we come to the only relation that plants have to "play." The struggle for existence and supremacy amongst themselves, although it might permit rest, would allow of no indulgence in "play," even if it were not inhibited by the line of life they have chosen, but in the share they take in the formation of golf links and playing fields, plants make some amends to man for his expulsion from an idle Eden. After play comes consideration of man's most intimate active relation with plants, that fundamental form of work, cultivation, which under flowers and fruits, vegetables and grains, is discussed with a wealth of allusion and illustration. Human interest in a derivative form of work, engineering, gives the keynote to three essays on the mechanical construction of plants, and on the methods by which they have solved the mechanical problems forced upon them by the conditions of their life, and have anticipated many of man's engineering devices. The physical properties of wood and bast, which permit of an amazing range of application from house-building and cloth-weaving to the divine music of the violin, are the subject of two chapters. In their final function in completing the full circle of the wheel of life, which starting from the inorganic, through the green cell returns to the inorganic through fungi and bacteria, plants are shown as the earth's prime sanitary agents and indispensable to man in his most advanced sanitary practice.

The close social life of plants and the various

expedients—ranging from mutually beneficial co-operation to the worst forms of parasitism—by which plants attempt to cope with the ever-pressing problems of over-population and unrestricted competition are admirably outlined in several chapters. These same problems bid fair to be the supreme ones of the future for humanity also, and in the human handling of them the world of plants is not only a living lesson and a warning, but will dictate some of the most important conditions for their solution. It is, therefore, well that the note of the concluding essays should be man's dependence and influence on vegetation. Prof. Bower rightly emphasises the tragic aspects of man's interference with the balance of plant life—and, as a consequence thereof, with animal life also. In this, as in other things, the evil wrought by one generation lives after it to plague those that follow. Happily one need not yet conjure up the dreadful vision of a day when man will have brought it about that over all the earth the desert will be the only contrast to the sown, but much depends on man using his powers with more discrimination in the future than he has in the past. It is in helping to spread appreciation of this, no less than in its enjoyable presentation of the life and work of plants themselves, that Prof. Bower's book has a value all its own.

Ether and Erdgeist.

Ether and Reality: a Series of Discourses on the many Functions of the Ether of Space. By Sir Oliver Lodge. (The Broadcast Library.) Pp. 179. (London: Hodder and Stoughton, Ltd., 1925.) 3s. 6d. net.

EVERYTHING that Sir Oliver Lodge writes bears so clear an imprint of his powerful and persuasive personality that a book bearing his name may be confidently anticipated to hold the reader's interest and stir his imagination. In the present little work such an expectation is not disappointed. Sir Oliver has a well-known enthusiasm for a massive, elastic, all-functioning ether of transcendent reality, and his whole-hearted belief finds expression in a lively, yet learned, eloquence which does justice to his theme. He treats of the ether in the most comprehensive spirit, and his book contains not only a survey of all the wider problems of physics in connexion with which an ether may be invoked, but also philosophy, elevating moral reflections, and an inspiring vision of the perfectibility of man.

The point of view is, perhaps, best expressed by a sentence taken from the chapter on "The Ultimate Physical Reality": "Speculatively and intuitively we feel to be more in direct touch with the ether than with matter." Sir Oliver regards the ether less as a working

hypothesis than as a revealed reality. He sees in it a possible vehicle for psychical manifestations of man's individuality—consciousness, memory, and affection. "It is the primary instrument of Mind, the vehicle of Soul, the habitation of Spirit. Truly it may be called the living garment of God." It is in almost these words that the Erdgeist in Goethe's *Faust* speaks of his activities:

"So schaff ich am sarsenden Webstuhl der Zeit
Und wirke der Gottheit lebendiges Kleid"

It is not on physical evidence alone that Sir Oliver relies, but on something of the mystic inspiration and psychic experiences which prompted the great poet's words.

In spite of the charm and simplicity with which the book is written, some difficulty may be experienced in understanding exactly what Sir Oliver wishes to lay down as regards the physical properties of the ether. For example, he says that the fact that the ether transmits waves proves that it must possess elasticity and inertia, because material bodies that transmit waves have these properties, and then says: "The possession of these properties makes the ether very real" But as the possession of a quasi-material mechanism must be postulated in order to endow the ether with these properties, this does not, to the present writer, appear convincing. Again, he says at one place that "Ether is not to be explained in terms of matter," but this, apparently, does not mean that the ether is not to be given many properties of matter. At the heading of one chapter he quotes a passage from Einstein containing the words: "But this ether may not be thought of as endowed with the quality characteristic of ponderable media," yet he nowhere discusses the difficulty presented by the fact that the ether cannot be used as a frame of reference. The present writer has no desire to carp: he gratefully acknowledges the pleasure he has got from reading the book, yet he cannot see what is gained by calculating a mass and an elasticity for an ether which has not the properties of a ponderable medium, so long as these properties of mass and elasticity serve only to explain the very transmission of waves which is the ground for their postulation. Of course, if they helped to understand cohesion or gravitation, of which Sir Oliver explains the ether to be the seat, or the behaviour of light in the neighbourhood of gravitating matter, every one would welcome them, but, as it is, to some they may well seem *entia praeeter necessitatem multiplicata*. There is, by the way, nothing said of the possibilities of Silberstein's ether of variable density, condensed at the surface of material bodies, which recent experiments suggest will have to be seriously considered.

The book is, of course, intended for non-technical

readers, and is bound to have a wide circulation and give delight to very many. The points that have troubled the present reviewer are very possibly not such as will trouble those approaching the book with a wider outlook. The general spirit of the little book is admirable, and, after all, that is what counts.

E. N. DA C. A.

The Study of Physical Chemistry.

- (1) *Physical Chemistry for Students of Medicine.* By Prof. Alexander Findlay. Pp. ix + 227. (London: Longmans, Green and Co., 1924.) 8s. 6d. net.
- (2) *L'Énergétique des réactions chimiques: leçons professées à la Sorbonne.* Par Prof. G. Urbain. (Collection de Physique et Chimie.) Pp. viii + 267. (Paris: Gaston Doin, 1925.) 25 francs.
- (3) *Les notions fondamentales d'élément chimique et d'atome.* Par Georges Urbain. (Science et civilisation: Collection d'exposés synthétiques du savoir humain.) Pp. iv + 172. (Paris: Gauthier-Villars et Cie, 1925.) 10 francs.
- (4) *Inorganic Physical Chemistry.* By Prof. G. H. Cartledge. Pp. xvi + 463. (Boston and London: Ginn and Co., Ltd., 1924.) 22s. 6d.

(1) PROF. FINDLAY'S "Physical Chemistry for Students of Medicine" recalls in its appearance as well as in its literary qualities the books by this author which are already familiar to all students of chemistry. It is, however, only necessary to read as far as the title of the second chapter, "The Aqueous Milieu of the Life Processes," in order to realise that the biological aspects of physical chemistry have been thrust into the forefront, in order to secure the interest and attention of the medical student, since it is not usual for a physical chemist to describe his favourite aqueous solutions and suspensions under so foreign a designation. The writer of such a book as this can achieve his object most readily by teaching the familiar and fundamental truths of his science with the help of novel illustrations derived from that field of applied science in which his readers are interested. We therefore find the problems of solubility, surface tension, viscosity and osmotic pressure illustrated by reference to the behaviour of blood and urine, and to the plasmolysis of cells or the hæmolysis of blood-corpuscles. This method, when used by a teacher of experience, not only interests the reader, but also has the further advantage of showing him how to apply the methods of pure science to his own specialised studies. No proof is needed to establish Prof. Findlay's skill as a writer on physical chemistry: the present volume appears to the reviewer to prove that he has at least familiarised himself sufficiently with the biochemical aspects of his

subject to enable him to provide a useful guide for biological workers who wish to join him in this field of work.

The author will perhaps pardon, as a personal weakness of the reviewer, the prejudice which makes him regard it as a retrograde step, after teaching the student to write the formula of an amino-acid as an internal salt, $\text{NH}_3^+ \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{O}^-$, to finish by asking him to regard this ion as having neutralised its two charges by swallowing its own tail, after the manner of a fried whiting. It is not every fish that can be induced to perform this acrobatic feat, and Pfeiffer's proof that "distance is no object" in preparing a betaine from an amino-acid, since these can be produced from *meta* and *para* as readily as from *ortho* aminobenzoic acid, seems to provide conclusive evidence that the amino-acids are under no obligation to strain their backbones in the manner suggested.

(2) Prof. Urbain's book on "The Energetics of Chemical Reactions" is the third volume of a new "Collection de Physique et Chimie," of which two preceding volumes, on "Colour and Chemical Constitution" and on "Thermochemistry," have already been reviewed in these columns (May 24, 1924, p. 739, and August 16, 1924, p. 240). Prof. Urbain claims that physical chemistry is not merely the overlapping section of physics and chemistry, but that it is a pioneer science which opens up new fields, which are afterwards added to the domain of these two sciences. He gives to his illustrious colleague, Le Chatelier, the credit for having been the first in France to introduce thermodynamics into chemistry, and asserts that "at the present time no one can call himself a chemist if he ignores the principles of thermodynamics and the method of applying them correctly to chemical phenomena in general, and more particularly to chemical equilibria." Such a test, if applied rigidly, would certainly exclude from the author's chemical "kingdom of heaven" some of our very "rich men," whose wealth of knowledge and experience could not be squeezed through the "needle's eye" of chemical thermodynamics. Whilst, however, we may repudiate the idea of excommunicating all those of our colleagues who are repelled instead of being attracted by the mathematical treatment of chemical problems, there is much to be said for the author's policy of writing a book on thermodynamics from the point of view of the chemist, rather than of the physicist or mathematician, and so minimising the difficulties of assimilating this method of treatment.

The book is in three parts, an introduction, which covers the general principles of thermodynamics, a very short section on thermochemistry (which has already formed the subject of a separate volume of this series),

and a third section, filling more than half the volume, on the "Modern Theory of Affinity." The treatment ignores all "atomic" explanations, not because they are regarded as of no value, but simply because they are superfluous to the object immediately in view. A further volume of the same collection is promised, in which the applications of the principles now taught will be discussed for their own sake, instead of being used merely as illustrations of general principles.

(3) Prof Urbain's book on elements and atoms is issued under the general heading of "Science and Civilisation" instead of "Physics and Chemistry." It deals with the definition of an element, radioactive elements, the constituents and structure of the atom, the relation between the properties of elements and the constitution of their atoms, and finally with isotopes. The International Table of Radioactive Elements is given on a folded sheet at the end of the volume. The author's style is attractive and interesting, and although he is addressing himself to an audience of general readers, his views on the question of how an element should be defined have a special interest at the present time for chemists. This question is discussed in a chapter of 50 pages, which occupies nearly one-third of the book, and the final conclusion, that the International Commission of the Chemical Elements was right, when in 1923 it reported that "an atomic number is necessary and sufficient to define a chemical element," is qualified by a final paragraph which contains a single brief sentence, asking whether "in the physical sciences, all definitions must not be only provisional?"

(4) Prof Cartledge's book appears to have been written in order to meet the need, in the curriculum of the Johns Hopkins University, of providing instruction in physical chemistry for undergraduate students, at such an early stage in their course that they cannot be assumed to be familiar with organic chemistry. This has led to the production of a book in which particular emphasis is placed upon the properties of aqueous solutions, including especially such subjects as hydrolysis, acidity and the formation of complex ions. Fortunately the author has not gone to the extreme limit of excluding *all* organic compounds from his consideration, since he has found it necessary to illustrate the vapour-pressures of aqueous solutions from the case of mannitol, their osmotic pressure by data for sugar-solutions, whilst the cryoscopic and ebullioscopic methods of determining molecular weights are illustrated by the use of benzene and other organic compounds as solvents. A still more notable example is that of "The Speed of Reactions," where the principal actions studied are derived from the field of organic chemistry.

Apart from sheer necessity, this subdivision of the field of physical chemistry appears to the reviewer to be wholly undesirable. Physical chemistry has now emerged from the grotesque stage in which it appeared to concern itself exclusively with the study of *dilute aqueous solutions*, and when Faraday was not classed as a physical chemist because his work was published before the foundation of the *Zeitschrift für physikalische Chemie*; the limitations imposed in the volume now under review have the effect of replacing the old fetters, and of making the least typical of liquids appear as the only typical solvent. Such limitations are entirely retrograde, and it is to be hoped that other universities will escape from the necessity of imposing them upon their teachers of physical chemistry.

T. M. LOWRY.

Climates of the Past.

Die Klimate der geologischen Vorzeit. Von Wladimir Koppen und Alfred Wegener. Pp. iv + 256. (Berlin: Gebrüder Borntraeger, 1924) 11s. 6d

THIS monograph on the climates of the past is essentially a supplement to Prof Wegener's work on continental drift. It endeavours to show that the former variations of climate can be best explained by Wegener's theory that all the land on the earth was originally one continuous continent which has been broken up, that the pieces have drifted apart, and that the north and south poles have migrated to their present positions.

The authors first discuss the nature of the geological evidence of former climates, and they claim, amongst other points, that all the great coal formations have originated either on moraines or on beds that have been recently folded. They then describe the distribution of climate in the Carboniferous and Permian Periods, and one of the most useful contributions in the book is the account of the glaciation of parts of the ancient continent of Gondwanaland, the section on the South American evidence is especially valuable. They next discuss the climatic zones in the Mesozoic and the Kainozoic, and follow with a chapter on the records of pre-Carboniferous glaciation which accepts without hesitation some cases that are regarded by some authorities as highly doubtful, and omits reference to other records. The final chapter discusses the Quaternary glaciation, which it attributes to variations in solar radiation.

The book gives tables of the solar changes in radiation for the past 800,000 years, and endeavours to fix the date of the successive glaciations. The discussion of the causes of the Pleistocene glaciation by two distinguished meteorologists shows that the theory of

its dependence on changes in solar radiation must be seriously considered.

The geological section of the book is a compilation of the facts which appear to support the authors' thesis, but it is often unconvincing from unfortunate selection of geological evidence. They accept, for example, the existence in the Silurian rocks of Bohemia and the Hartz Mountains, of *Lepidodendron*, *Stigmaria*, and *Sphenopteridium*—a conclusion which, if accepted, would render futile all recent palæo-botanical discussions on the beginning of the land flora. The authors' claim that the variations of former climates can be explained by a shift in the positions of the pole combined with a drift of the continents is not convincing even on their own evidence. Their work is most detailed in reference to the climate in the Carboniferous Period; yet the *Squantum* tillite occurs exactly on their Carboniferous equator; they reject that formation as pseudo-glacial, but it requires stronger evidence than the authors bring forward to explain it by any non-glacial theory. The distribution of the Jurassic climate also appears more consistent with Neumayr's view of zones concentric around the present poles than with the position the authors assign to the Jurassic poles, as they carry the boreal province within 20° of their equator.

The book has no index, which is an especially unfortunate defect, as its chief value rests on its extensive collection of information as to former glaciations and biological distribution from the scattered literature on those subjects. The book will be more useful from its summary of little-known facts than convincing of the authors' theory.

Our Bookshelf.

Contributions to Embryology. Vol. 16, Nos. 78-84. (Publication No. 361.) Pp. 276 + 32 plates. (Washington: Carnegie Institution, 1925.) n.p.

THANKS to the munificence of the late Mr Andrew Carnegie, American embryologists are enabled to place the results of their inquiries before the world in a superb form. The sixteenth volume of "*Contributions to Embryology*" maintains the high standard set by its predecessors, text and illustrations are excellent and the "contributions" are deserving of them.

The present volume, which includes seven papers, illustrates the new departures which are being made from recognised orthodox methods by modern embryologists. Only three of the seven papers follow conventional lines. Dr. F. Payne gives clear and exact drawings of reconstructions made of a human embryo in the fourth week of development; Dr. Cecil M. West makes a welcome contribution to later stages in the development of the gums and tooth-buds of human fetuses, while Dr. G. B. Wislocki describes certain new features in the placentation of the sloth (*Bradypus*

griseus). Prof. Alex. Maximow approaches the problems of embryology from the experimental side. He describes the behaviour of parts taken from embryos of rabbits and kept alive for various periods by methods adopted for the culture of living tissues. The results throw light on that kind of tumour which occurs occasionally in human beings and is known as an embryoma.

In a series of three papers, Prof. Florence Sabin, in collaboration with Dr. C. A. Doan and R. S. Cunningham, attacks the old problem of the origin of blood corpuscles by a new route—a physiological route. They have studied the production of new blood corpuscles in animals which had been rendered anæmic, using vital stains for the detection of the various kinds of corpuscles which are then produced. The result is the construction of a new schema of the ancestry of all kinds of cells which appear in blood or free cells which may be encountered in the tissues outside blood-vessels. Of great clinical importance is their discrimination of two forms of phagocytes—the clasmatoocyte, which arises from the endothelial cells lining capillaries, and the large monocyte which is produced from cells occurring in reticular connective tissues of all sorts; the latter, unlike the clasmatoocyte, arises outside a capillary lumen. It will thus be seen that modern embryology becomes more and more a branch of experimental research.

General and Physiological Features of the Vegetation of the more Arid Portions of Southern Africa, with Notes on the Climatic Environment (Publication No. 354) By. W. A. Cannon. Pp. viii + 159 + 31 plates. (Washington: Carnegie Institution, 1924) n.p.

THE author of this volume spent six months' leave in South Africa in the latter half of 1921. During that time he introduced Livingston atmometers to South African botanists, distributed through the Director of the Union Botanical Survey a number of standardised atmometers at various stations through the Union, and arranged for the recording of weekly evaporation; he visited the principal arid and semi-arid regions, sampled the characteristic plants and the transpiring power of their leaves, examined the leaf anatomy and root systems of Karroo plants, and took a number of excellent photographs. In the volume under notice the photographs are beautifully reproduced and the data he collected are brought together.

South African botanists will find much to interest and stimulate them, and will welcome the impressions of an observer with so varied an experience of arid regions, who can compare from first-hand knowledge the vegetation of the drier parts of their country with that of other parts of the world under comparable climatic conditions. His example will strengthen the movement already evident, from purely floristic towards ecological investigation of the South African flora. He has directed attention to those features of the plants which are of special importance in connexion with their water relations; and he has demonstrated that with a few simple appliances physiological data of value can be obtained out on the veld. Observations were even made on the transpiration of *Il'ehoutschia mirabilis* in the Namib desert; they suggest that the leaves of this curious plant transpire far more freely

than might have been anticipated from their xerophytic structure and the extreme aridity of the environment.

The atmometric data are somewhat disappointing. It is clear that they require a scrutiny to which the author had not been able to subject them at the time of publication, and are not uniformly trustworthy. A "Fig. 8" representing some of the data graphically, is referred to on pp. 44 and 55, but is not to be found in the book. There are also a regrettable number of printers' errors which have escaped correction. For example, "casual" appears in two successive lines on p. 3, in one or other of which it should surely read "causal"; while two variants on "Matjesfontein" appear on pp. 68 and 71. The "typography" of a district is referred to on p. 69, "Protaceae" for "Proteaceae" on p. 110, and so on.

Mechanical Refrigeration: being a Practical Introduction to the Study of Cold Storage, Ice-making, and other Purposes to which Refrigeration is being Applied. By Hal Williams. New and enlarged edition. (The Specialists' Series.) Pp. x+501+6 plates. (London: Sir Isaac Pitman and Sons, Ltd., 1924.) 20s. net.

THE volume under review is a new edition of Mr. Hal Williams's well-known book on mechanical refrigeration, which has now been amplified and largely rewritten. It contains a useful summary of the present state of our knowledge of refrigeration in its broadest aspect, and, as it does not go unduly into minute detail of design and equipment, it will appeal to all interested in the vital problem of the conservation of the food supply of the nation.

The book is descriptive rather than theoretical in its treatment of the subject, and a valuable feature is the account given of recent applications of refrigeration to such industries as paraffin crystallisation, mine shaft freezing, and so on. Another noteworthy feature in the new edition is the attention given to the high-speed total enclosed compressor. This type of compressor is an important step in the development of refrigerating machinery which has been taking place in recent years.

The general lay-out of the book partakes more of the nature of a dictionary than a text-book, for each paragraph is sub-headed under such titles as "Unit of Pressure," "Liquid Coolers," "Buying Machinery." This facilitates the use of the volume as a work of reference. The illustrations are plentiful and include a number of folding plates, but it is questionable whether these justify their cost in a book of this character. The author has given a prominent place to one very important application of refrigeration, namely, the overseas transport of fruit, for this industry is destined to be a vital factor in the development of the British colonies.

E. G.

A Catalogue of the recent Sea-Urchins (Echinoidea) in the Collection of the British Museum (Natural History). By Hubert Lyman Clark. Pp. xvi+iii+250+12 plates. (London: British Museum (Natural History), 1925.) n p.

DR. H. LYMAN CLARK, of the Museum of Comparative Zoology, Cambridge, Mass., who is one of the outstanding authorities on echinoderms, has given in this catalogue the results of his studies, extending over

some months in 1924, of the British Museum collection. This has been known as one of the important collections of sea-urchins since the time of J. E. Gray's first connexion with the Museum in 1824, in which year he published a paper—dealing with about 50 species—which may be regarded as the foundation for a catalogue. For thirty years Gray continued his study and, at intervals, his publications on sea-urchins. Since his time the collection has received notable additions from the expeditions of the *Challenger*, *Alert*, *Penguin*, and *Egeria*, from the collections made by Prof. A. Willey and Prof. J. Stanley Gardiner, and from those made during the recent British Antarctic Expeditions; it now ranks as one of the foremost collections of the world. It contains about 8000 specimens representing 382 species grouped in 146 genera, and Dr. Clark directs attention to the wealth of large examples in many of the series. He gives a table showing that in the collection is type material of 111 forms, 25 of which are new species or varieties described in this volume.

Dr. Clark has made available to students of the Echinoidea an accurate account of this great collection, and his catalogue serves also as a handbook for the identification of most sea-urchins. Twelve excellent collotype plates provide illustrations of the new species.

Recent Advances in Medicine: Clinical, Laboratory, Therapeutic. By Dr. G. E. Beaumont and E. C. Dodds. Pp. xii+292. (London: J. and A. Churchill, 1924.) 10s. 6d. net.

THE rapidity with which the study of medicine advances makes it necessary for the physician and clinical pathologist to keep constantly in touch with new methods of investigating and treating disease. With limited time and material for research, it is impossible for the busy practitioner to test these for himself, or to isolate from the vast accumulation of recent medical literature what is likely to be of practical value. In "Recent Advances in Medicine" a physician and a biochemist collaborate to give an account of the more important changes in clinical and laboratory routine methods of the last decade, and to indicate the relative value of the results obtained. The book covers a very wide field, including such subjects as blood analysis, renal, hepatic, and pancreatic functions, test meals, the polygraph and electrocardiograph, artificial pneumothorax, and various cutaneous and serological tests. Some of these might with advantage have received less attention; for example, the electrocardiograph and its tracings are of little value except to the specialist. X-ray investigation of the stomach, to which less than a page is devoted, is of far more interest to practitioner and student.

The book will be welcomed as a very useful addition to the practitioner's library. It contains numerous references and is excellently indexed.

Conformal Representation. By Leo Lewent. Translated by Dr. R. Jones and D. H. Williams. Pp. viii+146. (London: Methuen and Co., Ltd., 1925.) 7s. 6d. net.

THE work under notice is a translation of Dr. Leo Lewent's "Conforme Abbildung" (Teubner). It opens with an account of functions of a complex variable from the Cauchy-Riemann point of view. A long

chapter is devoted to special transformations, with detailed discussion of linear transformations and stereographic projections, but without reference to group theory. The account of algebraic transformations necessarily introduces Riemann surfaces, the two-sheeted ones being mainly considered. Riemann's conjecture, that any simply connected surface can be represented uniquely, continuously, and conformally on the area of a circle, has been made the foundation of many brilliant investigations by such mathematicians as Heine, Schwarz, Weierstrass, Osgood, Poincaré, and Koebe. A general account of the whole question is given in the book before us, without entering into the necessarily elaborate pure mathematics involved in much of the work on the subject. The last chapter, dealing with conformal representation by means of elliptic functions, was written by Dr. Blaschke, Dr. Lewy having died before his plan was completed. In the present translation, Dr. Jones and Mr. Williams have provided a very readable introduction to the theory of conformal representation. Some matters are discussed in the German text in a descriptive (rather than a scientific) way, but the translation is none the less acceptable on that account. W. E. H. B.

Kolloidchemie der Protoplasmas. Von Prof. Dr. E. Lepeschkin. (Monographien aus dem Gesamtgebiet der Physiologie der Pflanzen und der Tiere, Band 7.) Pp. xi + 228. (Berlin: Julius Springer, 1924.) 9 gold marks.

THE author has catered for the student in a very thorough manner, and devotes the first quarter of the book to a complete survey of the various physico-chemical phenomena associated with colloids, particularly proteins. The colloid chemistry of protoplasm is then developed and discussed from different points of view until finally the author presents a detailed and up-to-date account of the behaviour of protoplasm under the action of physical agents, such as temperature, light, and electricity, and that produced chemically by acids, alkalis, neutral salts, and non-electrolytes. One feels, however, that more might have been made of the effects of low temperatures and particularly of freezing temperatures, including, as it does, not only the temperature factor but also those due to desiccation and probably change in acidity. The book will appeal in particular to the plant physiologist.

There is one very fine plate containing twenty-two microphotographs of several living systems under different conditions, but surely a book of this nature is lacking in having no diagrams whatsoever. It is, nevertheless, well written, covers a wide field, and treats a difficult subject in a most interesting and clear manner.

A Monograph of the Birds of Prey (Order Accipitres). By H. Kirke Swann. Part I. Pp. xi + 52 + 5 plates. (London: Wheldon and Wesley, Ltd., 1924.) 26s. net.

In this monograph, which is being issued in twelve parts, Mr. Swann is bringing up-to-date the results of his recent intensive study of the diurnal birds of prey. In his introduction, which includes a chapter on falconry and hawking, it is stated that he now recognises 322

species and 692 subspecies or forms, while the genera employed number 100. In 1874 Sharpe (Catalogue of the Birds in the British Museum, vol. 1) gave the number of species as 377, but many of these are now considered subspecies. It will therefore be seen that in the last fifty years the number of apparently distinguishable forms has nearly doubled.

Part I. deals with the New World vultures and some of those of the Old World. Each form is separately discussed; its synonymy is given, then its distribution and different plumages in detail, followed by general remarks and notes on food and nesting. We are glad to observe that the status of each species is clearly shown; the typical race is first described; any subspecies bears the same number with the addition of a letter. This arrangement, we think, might with advantage be adopted by modern authors. The changes in nomenclature are many, and are in strict accordance with the rules of priority.

The letterpress and paper are excellent, and the coloured plates, which are by Mr. Gronvold, leave nothing to be desired. We heartily congratulate the author on the production of this work. The edition is limited to 412 copies.

Chemistry in the Service of Man. By Prof. Alexander Findlay. Third edition, revised and enlarged. Pp. xix + 300 + 4 plates. (London: Longmans, Green and Co., 1925.) 6s. net.

PROF. FINDLAY'S book, which has now reached a third edition since its first appearance in 1916, is one of the best accounts of modern chemistry for the lay reader. Unlike many books of this kind, it is written in a dignified style and without insistence on commercialism. The subjects dealt with cover various fields, and the book cannot fail to continue to be popular. It is very suitable for general reading by pupils in higher forms of schools as well as for those older readers who have not specialised in chemistry, since it supplements the ordinary text-books. Three new chapters on radioactivity and atomic structure, on the rare gases of the atmosphere, and on metals and their alloys, have been added in the new edition, and the whole has been revised and brought up-to-date.

The Rare Earths: their Occurrence, Chemistry, and Technology. By Dr. S. I. Levy. Second edition. Pp. xvi + 362. (London: E. Arnold and Co., 1924.) 18s. net.

THE volume under notice is especially characterised by its eminently readable style. The subject is dealt with exhaustively, yet the material is presented in such a way that an honours student could read the whole with profit, whilst the expert will find full references to recent work apart from the detailed treatment in the text. Methods of separation and tests are dealt with as well as the chemical properties of the elements, and the names, occurrence, and composition of the minerals. The book will be welcomed by chemists, and is well printed, and provided with an adequate index. Theoretical considerations of classification and atomic structure are considered, but a just sense of proportion has been preserved. The book contains all the information that the chemist who is not a specialist in this department will require.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Shapes of Birds' Eggs.

ANY notable geometrical symmetry in natural productions invites examination, and among such cases of symmetry the forms of hard-shelled eggs may be included. I remember, on chucking certain eggs in a lathe, being surprised to find that they ran nearly as true as if they had been turned, and there are several points of interest both in respect of the

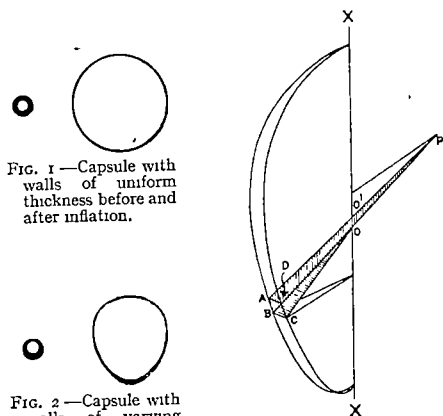


FIG. 1—Capsule with walls of uniform thickness before and after inflation.

FIG. 2—Capsule with walls of varying thickness before and after inflation.

FIG. 3.—To indicate the relation between the principal stresses and principal radii of curvature in a closed vessel.

close conformity of their shapes to solids of revolution and also in regard to the character of their generating curves.

Symmetry of this kind must have the same sort of origin as that of an inflated balloon, or of the aneurism which forms in an india-rubber tube when the internal pressure exceeds a certain limit.

No doubt the oviduct in which the shell is developed supplies the necessary pressure, whether acting merely as an elastic coat stretched by the growth of the contents, or by actual muscular stress in the non-striated fibres in its walls; the near approach, however, of the transverse sections to true circles implies that the pressure (measured in terms of head) is large compared with any difference of pressure between the upper and lower parts of the egg cavity, for although the pressure of the various parts in external contact with the oviduct must tend to balance the gravitational head in the interior, it is not likely that this balance is at all exact, and, as may easily be shown, small differences of pressure round the periphery of a transverse section would, in the absence of contractive force in the walls, produce comparatively large departures from the circular form.

From the measures given below, I should estimate that the pressure within the oviduct is of the order of a hundred times that given by a column of water of the linear dimensions of the shell. The forms of the generating curve of the solid of revolution must depend either on a variation of thickness in the elastic walls of the oviduct or a variation of muscular stress in its fibres.

This may be illustrated experimentally by the inflation of india-rubber capsules, as shown in Figs. 1 and 2. When the walls are of uniform thickness, inflation produces a sphere; if the cavity is eccentric, on inflation it assumes the egg shape. All the known shapes of eggs can in this way be reproduced by suitably adjusting the thickness of the walls.

The relation of the principal stresses and principal radii of curvature in a shell in which there is internal pressure can be deduced from Fig. 3.

Let the internal pressure be P , and let XX be the axis of revolution of the generating curve of the shell, and $ABCD$ an element of the surface of revolution. Also let $AP (= \rho_M)$ be the meridional radius of curvature and $CO (= \rho_L)$ that of the curvature in latitude. The tension T_M in the shell in the direction of the meridian is equal to $P \times \text{area } BCO - BC \times \text{thickness of the shell } (t)$, and in the direction of the latitude it is $P \times \text{area } ABOO' - AB \times t$. From this statement it can easily be shown that

$$T_M = P \rho_L / 2t \text{ and } T_L = P(2\rho_M\rho_L - \rho_L^2) / \rho_M t;$$

also, since the sum of the radial components of the tension must be equal to P ,

$$P = T_M / \rho_M + T_L / \rho_L,$$

and the ratio of T_L to T_M

$$(2\rho_M - \rho_L) / \rho_M.$$

If the solid of revolution is a cylinder, i.e. if $\rho_M = \infty$, this ratio, as is well known, is 2.

The forms of birds' eggs range from nearly spherical through ovals to bluntly pointed or peg-top shapes, and in this respect are, so far as my observation goes, much more variable than the hard-shelled reptilian or molluscan eggs; but in all cases there is a big and little end, and in laying, the big end comes out first.

A selection of typical forms of birds' eggs is given in Fig. 4. The eggs were placed on a photographic

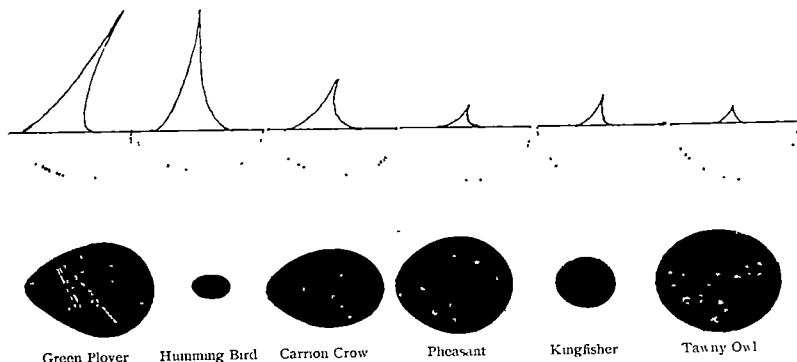


FIG. 4—Typical forms of birds' eggs.

Figures below are pinhole photographs of the eggs (about one-third natural size). Figures above (drawn to a uniform scale) show the generating curves as dotted lines, and the evolutes in full lines.

plate, vertically under a distant pin-hole, and the definition of the shadow picture is sufficiently good

¹ Since this was written I have been given a reference to a paper by Prof. D'Arcy W. Thompson (NATURE, June 4, 1908) on the shape of eggs. The relations given there between tension and curvature, due apparently to Prof. W. Peddie, are incorrectly stated.

to allow of the determination of the curvature with considerable accuracy

Above each figure (and on a scale which makes the long axis of all the eggs equal in length) is the evolute, which is more characteristic than the generating curve itself. The evolutes were produced by drawing normals to the generating curve at many points round the periphery, and though individual normals might in some instances be not quite correctly drawn, there could be no doubt about the shape of their envelope (*i.e.* the evolute). The ρ_c radii for any given latitude were so nearly constant that their variations could not be satisfactorily determined.

I give below, however, a few measures of the greatest and least equatorial diameters of ostrich eggs (too large to be photographed with the apparatus I was using), for in such large eggs, if anywhere, one might expect to find evidence of gravitational deformation.

OSTRICH EGGS

No.	Locality.	Greatest diameter.	Least diameter	Difference in parts per 1000	Remarks
1	Masailand . .	4 872 in.	4 865 in.	7	
2	"	5 042 "	5 021 "	21	Surface of shell rough.
3	Kilimanjaro .	4 892 "	4 890 "	2	
4	"	5 390 "	5 243 "	147	Surface of shell rough.
5	Wady Abuadh (?)	4 617 "	4 601 "	16	
6	" "	4 542 "	4 535 "	7	

I have to thank the authorities of the British Museum (Natural History), at South Kensington, for facilities in making these measures.

A MALLOCK.

9 Baring Crescent, Exeter.

Science in South Africa.

EVERY man of science will welcome General Smuts' interesting survey, appearing in *NATURE* of August 15, p. 245, of the problems that present themselves for solution in South Africa, for there is no more promising field of research, especially in geophysics.

The great astronomical observatories of the southern hemisphere are no doubt already co-operating in a daily comparison of wireless records and celestial observations, which will render it possible to determine in the course of the next few years whether there is at the present time any relative drift of the land masses of the south.

Not less important is a provision for systematic gravimetric observations, similar to those that have been carried out in the United States, Central Europe, India, and what was German East Africa. If these are sufficiently numerous, they will, in conjunction with the work of the Geological Survey, throw important light on the structure of the earth's crust.

At the same time, a number of seismological observatories should be established. The initial cost of the Milne-Shaw apparatus is comparatively small. As the records must be influenced by the geological structure at and near the receiving station, a careful and systematic comparison of the records at different stations of the same earthquakes should be very valuable.

Observations on the tidal movements and others of similar periods in the earth's crust, such as were made by Hecker at Potsdam, are also needed in South Africa for comparison with those in other parts of the world. They, too, will throw light on crustal structures.

For these and other lines of research South Africa affords unequalled opportunities of obtaining important results, and every one must look forward to see her take a place in the commonwealth of science equal to that of the most advanced of older communities.

JOHN W. EVANS

Transformation of Mercury into Gold.

THE experiments on the transformation of mercury into gold (A. Miethe and H. Stammreich, H. Nagaoka) and the suggested explanation of the process (F. Soddy) lead me to make the following observations. The possibility of the transformation of a nucleus into that of the element next below it by the absorption of one electron is most likely to be detected when both nuclei are stable. This occurs most obviously when the elements have a mass in common, an isobare, and, since even mass-numbers are not found in non-radioactive elements of odd atomic number, an isobare of odd mass-number.

At the present time there is no direct experimental evidence of the existence of isobares of odd mass-number among non-radioactive elements, but there are two cases where the possibility of their existence may be inferred from experimental work. These are the mass-numbers 205 and 199. The existence of the thallium isotope 205 is probable from F. W. Aston's general results for elements of odd atomic number and from the value, 204.4, for the atomic weight. I have given reasons for the existence of the lead isotope 205 (*Phil. Mag.*, 1924, [vi], 48, 365). From the atomic weight of gold, 197.2, it may be inferred that this element has isotopes 197 and 199; mercury, as F. W. Aston has shown, has the isotope 199. There are thus two pairs of elements, lead and thallium, mercury and gold, in which the transformation of the type under discussion may occur. I suggest therefore that the transformation of lead into thallium is as possible as that of mercury into gold, and that the masses of the thallium and the gold produced are 205 and 199 respectively.

There is a possibility that the transformation of lead into thallium by the process under discussion has already occurred in Nature. It has been pointed out by me that when any element of odd atomic number possesses two isotopes, the heavier is never in excess. Thallium did not appear to be an exception to this rule at the time it was made, as its atomic weight was accepted as 204.0 (the masses of its isotopes are assumed to be 203 and 205); it appeared to be one of the elements of odd atomic number like bromine, silver, and antimony, which have isotopes in approximately equal proportions. The new value, 204.4, of thallium's atomic weight, recently obtained, however, makes this element a definite exception. It is possible that the excess of the masses of 205 over those of 203 is the result of a process in Nature of an exceptional kind, for example, of the absorption of an electron by the nucleus of the lead mass 205.

A. S. RUSSELL.

Christ Church, Oxford,
August 12.

Gibbs' Phenomenon in Fourier's Integrals.

FOURIER'S integral $\frac{1}{\pi} \int_0^x f(\beta) \cos \alpha(\beta - x) d\beta$ is

known, under certain general conditions, to have the value $f(x)$ at a point where $f(x)$ is continuous and $\frac{1}{2}[f(x+0) + f(x-0)]$ at an ordinary point of discontinuity.

It would be natural to expect that the curves

$$y = I_a(x) = \frac{1}{\pi} \int_0^a d\alpha \int_{-\infty}^{\infty} f(\beta) \cos \alpha(\beta - x) d\beta,$$

for large values of a , would tend, in the neighbourhood of $x = 0$, to coincide with the line

$$x = 0, f(-0) \leq y \leq f(+0),$$

when $f(-0) < f(+0)$, the inequalities being reversed when $f(-0) > f(+0)$. However, as we shall now show, this line has to be produced above and below $f(\pm 0)$ by an amount

$$\frac{D}{\pi} \left| \int_{-\pi}^{\pi} \frac{\sin u}{u} du \right|,$$

where $D = |f(+0) - f(-0)|$, i.e. by about 9 per cent. of the jump D . This corresponds exactly to Gibbs' phenomenon in Fourier's series to which attention was directed by Gibbs in NATURE, vol 59, p 606 (1899).

It is sufficient to prove the theorem for a special case from the known properties of Fourier's integral at a point of continuity of the arbitrary function, it can then be extended to the general case.

We take $f(x) = 1$, when $0 < x < l$, and $f(x) = -1$, when $-l < x < 0$, and equal to zero elsewhere: so that $D = 2$ at $x = 0$.

Then it will be seen that

$$\begin{aligned} I_a(x) &= \frac{1}{\pi} \int_0^a d\alpha \left\{ \int_0^l \cos \alpha(\beta - x) d\beta - \int_0^l \cos \alpha(\beta + x) d\beta \right\} \\ &= \frac{1}{\pi} \int_0^l \frac{\sin \alpha(\beta - x)}{\beta - x} d\beta - \frac{1}{\pi} \int_0^l \frac{\sin \alpha(\beta + x)}{\beta + x} d\beta \\ &= \frac{2}{\pi} \int_0^{ax} \frac{\sin u}{u} du - \frac{1}{\pi} \int_{a(l-x)}^{a(l+x)} \frac{\sin u}{u} du \end{aligned}$$

It is easy to show that the second integral tends to zero when a tends to infinity, or, stated more carefully, to the arbitrary positive number ϵ , there correspond positive numbers A and η , such that

$$\left| I_a(x) - \frac{2}{\pi} \int_0^{ax} \frac{\sin u}{u} du \right| < \epsilon, \text{ when } \begin{matrix} a \geq A \\ 0 \leq x \leq \eta \end{matrix}.$$

Now the curve

$$y = \frac{2}{\pi} \int_0^x \frac{\sin u}{u} du \text{ for } x > 0$$

is situated above the axis of x and cuts the line $y = 1$ an infinite number of times. Its maxima occur when $x = \pi, 3\pi, 5\pi, \dots$ and continually diminish, tending to $y = 1$ in the end. Its minima occur when $x = 2\pi, 4\pi, 6\pi, \dots$ and continually increase, tending also in the end to $y = 1$.

Further the curve

$$y = \frac{2}{\pi} \int_0^{ax} \frac{\sin u}{u} du$$

is this curve, with the abscissæ reduced in the ratio $1 : a$. Therefore for large values of a the curve

$$y = I_a(x), \text{ when } x > 0,$$

rises from the origin to a point very nearly coincident with

$$x = 0, y = \frac{2}{\pi} \int_0^{\pi} \frac{\sin u}{u} du = 1 - \frac{2}{\pi} \int_{\pi}^{\infty} \frac{\sin u}{u} du = 1 + \frac{0.56 \dots}{\pi}.$$

A word or two of a historical nature may be added

regarding Gibbs' phenomenon in Fourier's series. As a matter of fact it had been described for the series mentioned by Gibbs in a paper entitled "On a Certain Periodic Function," in the *Camb and Dublin Math. Journal*, vol 3 (1848), by Wilbraham (B.A., Trin. Coll. Camb). To this point my attention was directed some time ago by Prof. G N Watson (see also *Enc. d math. Wissenschaften*, II. A, 12, p. 1049, and II C, 10, p. 1203). Wilbraham's paper seems not to have attracted any notice, and it had been completely forgotten when Gibbs sent his letter to NATURE in 1899.

Du Bois Reymond dealt with the behaviour of the approximation curves for series and integrals in *Math. Annalen*, Bd 7 (1874), in his paper "Über die sprungweisen Werthänderungen analytischer Funktionen." This memoir would have contained an account of Gibbs' phenomenon in both Fourier's series and integrals, if he had not made a curious slip with regard to the possible values of the integral

$\int_0^{nx} \frac{\sin u}{u} du$, when x tends to zero and n to infinity simultaneously.

Prof. Wilton, of Adelaide, noticed the existence of the phenomenon in Fourier's integrals in a paper, "On Gibbs' Phenomenon in Fourier's Series and Integrals" communicated to the *London Math. Society* in 1921. But his argument required further development and this paper has not been published.

The occurrence, or non-occurrence, of the phenomenon in Bessel's and Legendre's series, and in divergent Fourier's series, which can be summed by other means, has been discussed by various writers. It will be interesting to find if analogous results can be obtained in the case of Fourier's integral and other integrals equal to the arbitrary function.

H S CARSLAW.

Sydney, June 16

The Action of Silica on Electrolytes.

FROM Dr. Joseph's letter in NATURE of March 28, p. 460, it appears that our differences are mainly with regard to observation of facts. I therefore describe below the method of preparation of the hydrated silica used in most of our experiments: it was obtained from the hydrolysis of twice-distilled pure silicon tetrachloride. The silicon tetrachloride in the final distillation was collected in a *transparent fused silica flask*. The liquid was hydrolysed in the same vessel, and in the subsequent treatment only fused silica vessels were used. The silica was dried in air at room temperature in a place free from fumes. If Dr. Joseph finds difficulty in preparing the samples, I shall be glad to send him a sufficient quantity for his experiments. I would, however, point out that the silica used by Dr. Joseph differs from ours in one respect in that the silica was heated to 180°. We have found that, on ignition, the adsorptive capacity of hydrated silica diminished markedly, and probably the failure of Dr. Joseph to confirm our results is to be attributed to his having used samples which were "finally dried and heated to 180°."

We would request Dr. Joseph to repeat the following experiment with silica prepared in the manner given above: The silica is washed until the wash water after twenty-four hours' contact shows no opalescence with silver nitrate. It is separated in two equal portions to one of which a definite volume of pure water and to the other a definite volume of saturated solution of potassium nitrate free from chlorides are added respectively. If the two liquids are carefully decanted, the potassium nitrate solution

shows perceptible opalescence with silver nitrate, while the other does not. But if, however, the washing of the silica is carried on for a long time, even after the P_n of the wash water has become equal to that of the water used, the potassium nitrate solution fails to show any trace of a chloride.

Regarding the statement in par. 4 of his letter, I think Dr. Joseph is scarcely doing me justice in suggesting that these obvious precautions were not taken. The silica or the solutions never came in contact with filter papers. Transparent fused silica vessels were mostly used. Where glass vessels were used (resistance glass) it was ascertained that the results were not due to a reaction with the vessel. We have several times repeated and confirmed our observations.

Dr. Joseph says nothing about the increase in the negative charge of the surface at low concentrations of neutral salts, which to my mind definitely proves the primary adsorption of anions, and consequently of electrolytes including acids which contain these anions.

Similar experiments have been done with manganese dioxide, corroborating our point of view. We have communicated a paper to the Journal of the Indian Chemical Society, "On the Nature of Hydrolytic Adsorption, Pt. I," in which the theoretical considerations advanced in previous papers have been developed, and a brief summary of the results obtained in this laboratory during the last four years has also been given. Full experimental results will be published later.

I would take this opportunity to point out that we distinguish between three types of adsorption: (1) primary adsorption, resulting from the chemical affinity of the atoms on the surface (cf. Langmuir), (2) electrical adsorption, and (3) adsorption of solutes (or rather solutions) resulting from the capacity of the substance to adsorb water. The adsorption referred to in my letter in NATURE of April 4 (p. 497) is of the last-mentioned type, and is different from the small amounts of primary adsorption referred to in my letter of January 31.

J. MUKHERJEE.

Physical Chemistry Laboratory,
University College of Science and Technology,
Calcutta

Gas-pressure, Radiation-pressure, and Entropy in the Interior of a Star.

In the simplest form of Eddington's theory of stellar constitution (*vide* papers in Mon. Not. R. A. S., and *Astrophysical Journal*, 48, 205, 1918), the assumption is made that a certain quantity, β , is constant throughout a given star, β turns out to be the ratio of the gas-pressure to the total pressure (which is the sum of the gas-pressure and the radiation-pressure). The present note shows that the second law of thermodynamics provides a theoretical background for this assumption of Eddington's—justification of which has been largely empirical heretofore.

Write S for the entropy per unit volume at any point within a star, n for the number of molecules per unit volume, dV for a volume-element, and V for the total volume of the star. A feature of Eddington's method is that the volume, V , and the total number of molecules, $\int n dV$ (total mass divided by molecular weight), are supposed—at a certain point in the solution—to be given. Now S may be taken as a function of the two independent variables, V and n . Suppose that the distribution of matter within the star is infinitesimally varied, subject to the two restrictions mentioned; so that

$$\delta V = \delta dV = 0 \quad (1)$$

$$\text{and} \quad \int n dV = 0, \quad (2)$$

where the integrations are performed throughout the entire volume of the star. The condition for stable equilibrium is that the total entropy is a maximum, or

$$\delta \int S dV = 0 \quad (3)$$

In consequence of (1), this is equivalent to

$$\int n \delta S dV = 0 \quad (4)$$

Comparison of (4) and (2) necessitates that

$$\frac{\delta S}{\delta n} = b, \quad (5)$$

a constant throughout V .

It remains to express the relation between b and β . Taking the entropy as that of the radiation alone,

$$S = \frac{4}{3} a T^3 = \frac{4}{3} \frac{p'}{T},$$

where T is the absolute temperature of the elemental region, aT^3 the radiant energy per unit volume; and p' the radiation-pressure. Since the gas-pressure, p , is given by nRT (where R is the gas-constant per molecule),

$$S = \frac{4}{3} n R p' / p \quad (6)$$

Comparing with (5),

$$b = \frac{4}{3} \frac{R p'}{p} = \frac{4}{3} R \frac{1 - \beta}{\beta},$$

and β is constant throughout the star.

This treatment neglects the entropy of the gas. Furthermore, owing to varying ionisation with the varying distributions of matter, (2) above is only an approximation. Consequently the way is left open for more refined theories, according to which β and b may not be constant throughout a given star.

JOHN Q. STEWART.

Princeton University Observatory,
July 28.

The Experimental Transmission of Cutaneous Leishmaniasis to Man from *Phlebotomus papatasi*.

SERGEANT, ED. et ET, Parrot, L., Donatien, H., and Béguet, M. (C. R. Acad. Sci., vol. 173, No. 21, pp. 1030-1032), first successfully transmitted cutaneous Leishmaniasis to man from sandflies. Their experiment consisted of dividing a batch of 559 sandflies into 23 batches, crushing the sandflies in saline, and inoculating scarified points on the arms of volunteers. The sandflies were caught in Biskra, an endemic centre of cutaneous Leishmaniasis, and the experiment was performed in Algiers, where locally acquired cases of the disease are unknown. One experiment (from a batch of 7 specimens of *Phlebotomus papatasi*) was successful, Leishman-Donovan bodies being found from a papule which appeared 2 months and 24 days after the experiment.

A batch of 198 sandflies (191 *Phlebotomus papatasi*, 16 ♂♂ and 175 ♀♀, 7 *P. minutus*, 1 ♂ and 6 ♀♀) were caught in Jericho on June 25 last, and brought to Jerusalem for dissection. On June 26 a female *Phlebotomus papatasi* was found heavily infected with *Herpetomonas*, flagellates being present in the oesophagus, oesophageal diverticulum, midgut, and hindgut. The alimentary tract contained no trace of blood and the abdomen was full of ripe or almost ripe eggs. A large number of the flagellates were found attached to the under surface of the oesophageal

valve. Only fully developed flagellates were present, and Leishmaniasis form parasites and intermediate forms were not observed. A part of the material was stained and mounted and the remainder was used for the experiment. Two points on the left forearm of a volunteer were scarified and inoculated with material containing flagellates on June 26. On July 31 a small papule which would normally have passed unobserved was noted on one of the inoculated points, and on examination Leishman-Donovan bodies were found, i.e. the incubation period was less than half of that noted by the Sergeants and their collaborators. Nothing was noted on the other site of the inoculation, but it was examined and up to the time of writing has proved negative.

It must be further noted that the insect from which the material for the experiment was obtained was the only one from the batch of 198 which contained *Herpetomonas*.

The method of dissecting individual sandflies and experimenting with a positive individual is more satisfactory than crushing batches in saline and experimenting with the product, for in the latter case it is impossible to know whether a negative result is due to the fact that the sandflies contained no *Herpetomonas* or whether the *Herpetomonas* was non-infective.

For various reasons we do not think that the successful experiment of the Sergeants and collaborators and our own experiment provide a complete explanation of the etiology of cutaneous Leishmaniasis, and we intend to discuss this point elsewhere. It must be pointed out that Patton has on several occasions pointed out the necessity of the experiment performed by the authors (Bull. Soc. Path. Exot., vol. 12, No. 8, pp. 500-504, and *Ind. Jour. Med. Res.*, vol. 9, No. 3, pp. 496-532).

S. ADLER.

O. THEODOR.

Microbiological Institute, Jerusalem,
P.O.B. 250, August 5.

Spiral Springs of Quartz.

MAY I express my interest in your recent correspondence on quartz spiral springs (NATURE, June 20, p. 943, and July 4, p. 14), and suggest a convenient laboratory method for the production of springs of extreme sensitivity. I refer to the use of fibres the diameter of which is 10^{-3} cm. or so.

One end of a length of fibre is weighted and the other attached to a transparent quartz tube by fusion. This is accomplished simply, by heating to incandescence a small portion of the tube in an oxygen flame and quickly lowering the heated spot on to the fibre, which is held at right angles to the axis of the tube. A perfectly strong joint is made and the loaded fibre may be wound up at the desired pitch (difficulties arise owing to air-currents if the tube is not lowered on to the fibre). A similar procedure serves to finish off the spiral: a small portion of the tube, say 1 cm. away from the windings, is heated to incandescence, and, tilting the tube, the last turn of the spiral is wound over the hot spot. The spiral with its supporting tube is now placed axially in a wire wound resistance furnace and heated rapidly in air above the annealing point of fused silica—1 minute at 1100° C. is adequate for a fibre 10^{-3} cm. diameter wound on a diameter of 1 cm. No trouble from devitrification is experienced and the elastic properties of the fibres are unimpaired; moreover, the curvature of the coil is uniform throughout.

Removal is best accomplished by unwinding slightly one of the end turns of the spiral; bending it outwards from the tube and away from the coils. In this position the end may be secured to a rigid

support by any suitable adhesive, the remaining turns being similarly opened and wound off. In this process a single camel hair is useful to guide the motion of the fibre, and is best used without artificial aid to vision. As an example of sensitivity, a spring so made with which I have experimented has an expansion rate of 3×10^6 cm. per gram, this measured by deformation under its own weight.

By careful regulation of the time and temperature of heating, a coil may be made, which, when released at its ends, is of larger diameter than the tube on which it was wound. Incidentally, this technique for producing springs of varying curvature, under specified conditions of time and temperature, offers a very convenient method for the study of the annealing of vitreous bodies, since a simple series of experiments gives quantitative information as to the time rate of the release of strain.

H. D. H. DRANE,
Research Dept., Thermal Syndicate,
Wallsend.

Fish Poisons as Insecticides.

THE destruction of fresh-water fish by means of the poisonous properties of certain plants is almost as widespread as the use of the conventional form of fish trap in one or other of its common modifications. Like the savages of many tropical countries, the poachers of Southern Ireland employ a vegetable fish poison, and this they obtain from spurge (*Euphorbia hibernica*). The primitive method of use is merely to put the freshly gathered plant (leaves, stem, and root) into a sack and tread on this vigorously in the shallow water at the head of a pool. The expressed juices mingle with the water and rapidly render all fish helpless for, it may be, three-quarters of a mile downstream. It is said that affected fish never recover, and the amount of destruction wrought, especially in streams where quantities of salmon parr and small trout exist, can easily be imagined.

The more modern method of application is, I understand, to crush and chop the plant in a chaff cutter or some similar agricultural machine, collect the juice in a bottle, and put this into the stream either with, or without, the chopped-up plant.

If it were found that the spurge poison is also valuable as an insecticide, the plant would probably be more easily obtained, or cultivated, than some of the tropical forms.

Flax water, the scourge of certain rivers in Northern Ireland, is in its effects at least as deadly as spurge, but its effect is due to the product of the decomposition of the softer parts of the flax plant in water and not the juice of the plant itself.

W. J. M. MENZIES.

Fishery Board for Scotland,
Edinburgh, August 17.

The Word "Australopithecus" and Others.

NEITHER Dr. Bather nor Dr. Allen (NATURE, June 20, p. 947, July 25, p. 135) directs attention to the fact that the names of all well-regulated families or sub-families should be based on a generic name, so that the term *Homosimiidae* is ill advised. As for the name *Australopithecus* and any other combinations, it might be said that scientific names are not, strictly speaking, literature, though so regarded by the orthodox. Many years ago Le Conte, to show that a name need not necessarily mean anything, gave the name *Guyascutus* to a genus of beetle.

F. A. LUCAS,
Honorary Director,
The American Museum of Natural History,
New York City, August 6.

Moseley's Work on X-rays.

By SIR ERNEST RUTHERFORD, O.M., F.R.S.

TO the many friends of the late H. G. J. Moseley, who was killed in action at Gallipoli in 1915, it has always been a matter of regret that no reasonable portrait of him could be found. Apparently Moseley had an objection to placing himself in the hands of the professional photographer. Recently, Mr. N. Garrod Thomas kindly sent me the negative of a snapshot of Moseley taken probably in the Balliol-Lincoln Laboratories at Oxford in the summer of 1910, about the time of his graduation and before he took up a post as lecturer in physics in the University of Manchester. A part of this negative has been enlarged by Mr. W. H. Hayles, of the Cavendish Laboratory, and is here reproduced.¹ I think all will agree this is an admirable portrait of Moseley. It is difficult to be certain of the apparatus in his hands, but it may have been connected with a repetition of some of the expansion experiments of Prof. C. T. R. Wilson, which it is known he carried out about that time.

In an obituary notice in this journal (Sept. 9, 1915), and also in a special notice in the Proceedings of the Royal Society in 1916, I gave an account of Moseley's life and work, and directed attention to the fundamental importance of his two papers published in the *Philosophical Magazine* (Dec. 1913, April 1914), entitled "The High Frequency Spectra of the Elements." In these

papers he formulated for the first time the law, now known as Moseley's Law, governing the X-ray spectra of the elements, and by its aid was able to fix definitely the number and order of the elements. While the importance of these brilliant researches was immediately recognised, now that a decade has elapsed we can appreciate even more clearly the significance and fundamental character of his discoveries and can estimate the extent to which his work has influenced the development of modern physics.

In this connexion it may not be inappropriate to recall briefly the theoretical position at the moment Moseley began his investigation and the subsequent developments. The nuclear theory of the atom had

been advanced in 1911, and from the results of experiments on the scattering of α rays, it had been suggested that the nuclear charge of an atom might be given by the atomic or ordinal number of the element. On the nuclear theory, the properties of an atom are defined mainly by its nuclear charge, since this controls the number and arrangement of the outer electrons.

Following the discovery in 1912 by Laue, Friedrich, and Knipping of the diffraction of X-rays by crystals, W. H. and W. L. Bragg in 1913 had found evidence by the electric method of the presence of bright lines in the spectrum of platinum, using the method of reflection of crystal faces. These results were confirmed and extended by an investigation by Moseley and Darwin, published in the same year.

At this stage I remember well a discussion with Moseley, in which he proposed a research to test whether an examination of the X-ray spectra of a group of elements could give a decisive answer to the question whether the properties of an atom are defined by its atomic number, as suggested by the nuclear theory, or by its atomic weight, as indicated by the periodic law of the elements. As we know, his hopes were strikingly verified. He rapidly examined by the photographic method the K spectra of a group of the lighter elements and the L spectra of a number of the heavier elements. The conclusions reached by Moseley are clearly given in the terse summary in his second paper, which for its interest is reproduced here.

1. Every element from aluminium to gold is characterised by an integer N , which determines its X-ray spectrum. Every detail in the spectrum of an element can therefore be predicted from the spectra of its neighbours.

2. This integer N , the atomic number of the element, is identified with the number of units of positive units of electricity contained in the atomic nucleus.

3. The atomic numbers for all elements from Al to Au have been tabulated on the assumption that N for Al is 13.



Henry Gwyn Jeffreys Moseley, 1887-1915.

¹ I have arranged with Mr. Hayles to provide copies of this enlargement at a small charge.

4. The order of the atomic numbers is the same as that of the atomic weights, except where the latter disagrees with the order of the chemical properties.

5. Known elements correspond with all the numbers between 13 and 79 except three. There are here three possible elements still undiscovered.

6. The frequency of any line in the X-ray spectrum is approximately proportional to $A(N-b)^2$, where A and b are constants.

Apart from (2), the conclusions drawn in Moseley's paper are a straightforward interpretation of the experimental facts and involve no theoretical assumption as to the nature of radiation or the structure of the atom.

Moseley's identification of the atomic number as a measure of the nuclear charge afforded an interpretation of the frequency law he had found in accord with Bohr's quantum theory of spectra, which had been published previously. The correctness of this identification has since been verified by Chadwick by direct measurement of the scattering of α rays by the nucleus.

As a result of these brilliant experiments of Moseley, a relation of unexpected simplicity is seen to hold for all the elements. The properties of an atom are defined by a whole number which represents the ordinal or atomic number of the element and, at the same time, its nuclear charge and the number of electrons external to the nucleus. The atomic weight turns out to be in a sense a secondary property and the periodic law of the elements is put on a wider and more philosophical basis by the substitution of the atomic number or nuclear charge for the atomic weight of the atom.

The work of Moseley has formed a solid and indispensable foundation for the subsequent attack by an army of researchers of the great problem of the constitution of the outer atom. His frequency law has proved an invaluable aid in interpreting the intricacies

of X-ray spectra and their relation with atomic constitutions—a subject on which so much fine work has been done in recent years.

We have seen that Moseley showed that all possible elements, disregarding isotopes, had been discovered up to number 79 except three.² numbers 43, 61, and 75, and he stated "as the X-ray spectra of these elements can be confidently predicted, they should not be difficult to find." The study of the X-ray spectra affords a powerful and unique method of chemical analysis of a mixture of elements; subsequent research has shown that the presence of an element can be detected with certainty and its amount estimated by its X-ray spectrum even if it be present only to the extent of one part in a thousand. The first of these missing elements found by this method, namely, number 72, was called hafnium by Hevesy and Coster. In this case the method of X-ray analysis was all-important since hafnium is always found with zirconium, with which it is chemically so closely allied that separation is very difficult.

If the other missing elements existed in appreciable amount in minerals, their detection seemed certain. A few weeks ago it was announced by Dr. Noddack and Fraulein Tacke that the missing elements 43 and 75 had been identified by their X-ray spectra in material separated from certain platinum minerals. A preliminary account of their investigations has been given in this journal of July 11. One element, 61, in the rare earths remains unidentified; but for this, Moseley's list of numbers is complete from 1 to 84.

Moseley had the spirit and courage of the true pioneer in science, coupled with great original ability and powers of work. It is rare in the history of science that so young a man has achieved so much.

² In making this statement, Moseley assumed that number 72 had already been filled by a rare earth element cerium. As we now know, number 72 had not been isolated at the time Moseley wrote. There were not three but four gaps.

Concerning the Rate of Man's Evolution.¹

By SIR ARTHUR KEITH, F.R.S.

BEFORE proceeding to discuss my subject—"The Rate of Man's Evolution"—it may be well to ask the question: Is evolution at work in England to-day? Are the Londoners of to-day taller than those of two, ten, or twenty centuries ago? Any one who sets out to answer this simple question is brought face to face with the difficulties which encompass the inquiries of the student of man's evolution. His difficulties are those of variability. The men and women we meet on the streets are of varying height; to strike a true average for the stature of Londoners we must measure hundreds of individuals in every district of this great city. Nor would our average for London hold for the men and women of Birmingham, Manchester and Newcastle, nor would the averages for these cities hold for their surrounding districts. To know the average stature of men and women now living in England entails the measurement of many thousand individuals.

Until the War we believed that the average Englishman stood 5 ft. 8 in. in height; figures gathered then compel us to reduce our estimate by nearly 2 in. When we search the ancient graveyards and burial-places of

England to ascertain the average stature of the men and women buried in them, our difficulties are even greater. The people buried in ancient tombs differed in height just as much as we do; the numbers available for measurement are limited; we have to estimate stature from the length of their limb bones. If we are uncertain of our modern stature, we are still less certain of that of former times. Still, if for the moment we dispense with the precision of the biometrician, we may say that there has been no great change in the stature of the inhabitants of these islands since the close of the Ice Age, some 12,000 years ago. There have been "ups and downs," but the mean for modern Englishmen of 5 ft. 6 in. may be taken as the pivot on which the scales of stature have been balanced for thousands of years.

When we apply measurement to the size and form of head, and compare the dimensions of modern Englishmen with those of former times, we are again confronted with the perplexities of variability. In the third millennium B.C. the skulls of England were long and narrow. About the beginning of the second millennium the eastern and southern parts were settled by a people with short and wide skulls; in the first millennium,

¹ Discourse delivered at the Royal Institution on Friday, March 6.

probably as a result of a new influx, the long and narrow skull again asserted itself. In Roman times, and more particularly in Saxon times, the long and narrow skull prevailed. Measurements made on living Englishmen lead to the belief that the head-form has changed and is changing—becoming slightly shorter and slightly wider. There is evidence of a similar change in the head-form of the people in Egypt. So far as concerns the brain-capacity of the skull there is no evidence of increase. From the limited data at our disposal we must infer that the people who occupied western Europe at the close of the Ice Age stood distinctly above their successors of to-day in the matter of brain-size.

I have said that in certain details of bodily structure the Egyptians of to-day do differ from the men who built the great pyramids some 5000 years ago. This, however, is not the accepted opinion. Those who maintain that modern man has ceased to evolve cite the similarity between modern and ancient Egyptians to prove their contention. Only ten years ago I was of opinion that the evidence from England led to the same conclusion. My opinion was altered by certain investigations I carried out in 1914-15. I took fifty skulls (twenty-five of men and twenty-five of women) from English graves which were known to be 1000 years old or more; some of them were as ancient as the pyramids. I instituted a minute comparison between these ancient skulls and those of corresponding numbers of men and women who had lived in England during the eighteenth and nineteenth centuries.

The result of this comparison was to convince me that evolution is now at work on our bodies. The chief change is to be seen in the size and shape of the palate; the roof of the mouth tends to become reduced in size and to become narrower. The bony entrance to the nose shows alterations. It tends to become narrower and its lower margin to rise up so as to form a sharp bony sill. The jaws recede and the bony framework of the nose becomes more prominent. The sockets for the eyes become changed in form, the lower margin or sill of the orbit tends to sink downwards in the face, thus increasing the distance between the lower and upper margins of the orbit. At the same time the orbits become narrower from side to side; the breadth across the upper part of the face becomes less. The cheek bones lose their prominence, and there is a tendency for the face to grow narrower and longer.

It may be said that the changes I have described are due to a diminished use of the jaws in modern people, for the jaws form a large and intrinsic part of the face, and any reduction in size and strength in jaws must necessarily alter the whole face. I do not think we can accept a diminished use of the jaws as a true explanation, for this reason. The changes which I have described are confined to about 30 per cent. of the modern population. 70 per cent. show no such change, and yet all live on approximately the same dietary. The cause lies deeper than a mere disuse of jaws, certain stocks and families show these changes to a more marked degree and more frequently than do other stocks and families. Such evidence as I have gathered points to an increasing frequency of these new characters during recent centuries. Apparently evolution makes its conquests in the way just described, progress is made by climbing the scale of percentages.

The result of this investigation took me rather by surprise, for I had been of opinion that men of our type had lived in England for a hundred thousand years or more and retained their essential characters almost unchanged. This belief was founded on a famous discovery made at Galley Hill in 1888. The schoolhouse of Galley Hill occupies a bluff on the southern bank of the Thames, half-way between Dartford and Gravesend. Standing by the schoolhouse we look northwards across the valley to the flat lands of Essex, Tilbury docks, the scene of another famous discovery of ancient human remains, is clearly visible on the far bank of the river. The bluff on which the schoolhouse stands rises 100 feet above the level of the river, between the bluff and the river lies a stretch of marsh fully a mile wide. On the bluff, close by the schoolhouse, is a pit, dug by cement-workers, now disused, but a busy place in 1888. The workmen had exposed a series of beds, consisting of gravel, sand and loam, which extended downwards fully 10 feet below the surface soil. In the lowest bed but one the workmen began to expose parts of a human skeleton; it lay 8 feet below the original surface. At the same level large primitive flint implements had frequently been found. Was the skeleton thus discovered the remains of one who had helped to fabricate these instruments?

Over the skeleton the original beds were seen to be intact, if there had been a burial, these beds should have shown definite signs of having been broken. The workmen and two other observers, who examined the section while some of the bones were still untouched, were convinced that the skeleton had become naturally entombed when the beds of sand and gravel were being formed. As to the man thus brought to light there can be no doubt. I have spent many hours in examining his bones. His skull, jaws and limb bones are marked by certain primitive features, but every one of these can be matched in the skeletons of men who are living in England to-day or have lived in recent times. Galley Hill man was of the modern European type.²

Try as I could I did not see how the geological evidence at Galley Hill could be set aside, and I accepted the inevitable conclusion that Galley Hill man was as old as the strata in which he lay. How old are these strata? They are records of the ancient history of the Thames valley. The river made the valley and wrote its records. The gravel deposits on the bluff at Galley Hill are but a fragment of the terraces which fringe both sides of the valley of the Thames at the 100 feet level. These fringing terraces were laid down in the bed of the river or on the shores of its estuary. They tell of a time when the land on which the older and richer parts of Westminster and London now stand lay fathoms beneath the waters of the estuary, and buried deeply by the deposits which accumulated as tides flowed and ebbed.

Geologists recognise other and later terraces of the Thames valley. There is an extensive series at the 50 feet level. Piccadilly runs along this terrace; the foundations of the Royal Institution penetrate its sands, gravels and loams. There are still later deposits of the 25 feet terrace. The Admiralty Buildings, the Houses of Parliament and the Horse Guards stand on this

² The circumstances of this discovery and the character of the skeleton are described in my "Antiquity of Man," second edition, 1923.

terrace. We find in this terrace deposits which mark the close of the Ice Age in England, a date which geologists regard as about 10,000 or 12,000 years distance from us. It is clear, then, that much has happened in the valley of the Thames since the river began to lay down the deposits which make up the 100 feet terrace. If geologists did think in terms of years, there are few who would limit the history of this period of the Thames valley to a term of 100,000 years; many, I am sure, would demand twice this sum. If Galley Hill man is as old as the deposit in which his bones lie, then the rate of man's evolution has been so slow as to be almost imperceptible.

In recent years a new light has been thrown on the history of the Thames valley by a simple discovery. Women know that every hat and coat is dated by its cut or design; they believe that fashion began her imperious sway in modern times. Archaeologists and geologists groping amongst the dust heaps of the past have found that mankind has always been the slave of fashion. At all times man has shaped his implements according to the prevailing fashion of the place and period. His handiwork is just as datable as are our hats and houses. French archaeologists, when they began to explore their caves methodically some sixty years ago, made this discovery; they began to work out the sequence of fashions. It was soon found that the system discovered in caves could be applied to the deposits or terraces of river valleys. The fashions of the river valleys went a long way further into the past than did those of the caves. The deposits of the 100 feet terrace of the Thames valley, for example, were found to contain fashions of three consecutive periods. For the deepest and oldest bed of all implements were worked in a pre-Chellean manner; in the strata just over the burial bed of Galley Hill man implements were of full Chellean workmanship; in the more superficial strata they were worked in the Acheulean manner. Thus, if we admit that Galley Hill man is truly of the same age as the 100 feet terrace, then his culture is that of Chellean man. The implements of this period often show evidence of high skill in the working of flint.

When the fossil remains of Galley Hill man were discovered, we had only geological data to assist us in fixing their antiquity. Since then a new source of evidence has come to light. In the deposits on the sides of our valley—in the strata of its terraces—there is a complete sequence of the cultural phases of the Pleistocene period. We can trace all the stages which link the cultural debris now being entombed by the Thames in its bed to the pre-Chellean implements which were engulfed when the deepest and oldest stratum of the 100 feet terrace was deposited. Galley Hill man lay in the middle or Chellean strata of that terrace. Those who have studied the sequence of Pleistocene cultures, and have assigned just estimates to each, suppose that the Chellean phase of culture was moving towards its zenith 100,000 years ago. If we base the age of Galley Hill man on cultural evidence, we have to assign to him an antiquity of 100,000 years. If we accept this age, then we have to infer that the type of man now found in Western Europe has come through the greater part of the Pleistocene period without undergoing any great degree of change.

Let us now look at the evidence relating to man's

antiquity which has been accumulating these past years on the continent of Europe. The Neanderthal type of man, which we are to investigate first, belongs to the Mousterian phase of culture, one which is much more recent than the Chellean. Most authorities would date the beginning of the Mousterian phase at about 40,000 B.C., and its concluding phase as about 20,000 B.C. All the graves of this long period—from Gibraltar in the south to the centre of Germany in the north—contain remains of only one type of man, the primitive Neanderthal type. The bones of the modern type—Neanthropic man—are never met with. We must thus conclude that the European of the long Mousterian period was Neanderthal man.

Further, the discoveries made at Ehringsdorf, near Weimar, and in the Mauer sands near Heidelberg, have revealed older and more primitive representatives of the Neanderthal type. Heidelberg man is as old as the deepest bed of the 100 feet terrace of the Thames valley; he belongs to the opening phase of the Pleistocene period. Thus all the evidence from the continent leads us to believe that Europe was inhabited by men of the Neanderthal type throughout the greater part of the Pleistocene period. They underwent a considerable degree of evolution before their type was extinguished at the end of the Mousterian period. There are only two items of evidence which clash with this interpretation—namely, the discovery made at Galley Hill, and another at Clichy, in Paris, where human remains, very similar to those of Galley Hill, were found in a stratum of Chellean date.

All authorities are now agreed that the Mousterian period closed some 20,000 years B.C. with the sudden appearance in Europe of men of the modern type. These forerunners of the modern European were big-brained fellows, in every respect of our own type, save that all of them were strong-jawed and had countenances cast in a somewhat rugged mould. A little toning down of these characters would convert them into modern Europeans. It is clear that these forerunners which broke into Europe at the end of the Mousterian period had evolved elsewhere. We have not yet found their cradle-land. I suspect that it will be found in the northern stretches of the Sahara, or perhaps farther to the east—in Arabia or Southern Turkestan. If only we could discover the prototype of the European and assign a geological date to it, we should settle once and for all whether it was possible for men of the modern type to have made a settlement of Europe during the Chellean period, from which they were afterwards expelled by Neanderthal man, or whether his first appearance in Europe was that made at the end of the Mousterian period, when he conquered and extinguished Neanderthal man. If we accept the first alternative, then the evolution of the European type has been slow; if we accept the second, then it has been more rapid. Circumstances force me towards accepting the latter alternative.

Let us turn for a moment to another representative of mankind at the beginning of the Pleistocene period—Pitldown man. I think we are all agreed that his culture was pre-Chellean, and that his period is represented by the deepest and oldest bed of the 100 feet terrace. He thus belongs to an older and more primitive cultural period than that of Galley Hill man. In

form of skull and in size and pattern of brain, this early representative of Pleistocene humanity does not differ markedly from living races, if not actually on our line of descent, the Piltdown type cannot be far removed from it. The anthropoid characteristics of his jaws and teeth are the chief obstacles to placing the Piltdown type on the direct line of our ancestry. We may presume, however, that our direct ancestor had reached as high a stage at the dawn of the Pleistocene period as that attained by Piltdown man. Even then evolution must work with some rapidity if the modern European is to be produced before the Pleistocene period had closed.

We must also take into consideration that remarkable fossil type of man discovered in Java, to which the name *Pithecanthropus* has been given. We may accept the date ascribed to him by his discoverer, Dr. Dubois, as late Pliocene. He is thus older than either Piltdown man or Heidelberg man. His brain possessed distinctively human features, but it is much smaller, much less evolved than any hitherto ascribed to man. His skull and his brain, so far as we know them, stand midway between the status of ape and man. To transform this ancient type of Java into the most primitive of living human types, evolution would have to proceed at an extremely quick pace. It is easier to believe that *Pithecanthropus* represents the persistence of an early Pliocene type than that it represents the stage reached in human evolution at the end of that period.

The discovery made in the Broken Hill mine, South Rhodesia, in the autumn of 1921, must also be taken into account. Here was brought to light the fossil remains of a primitive human type. Rhodesian man may be described as the cousin of Neanderthal man, but was more primitive in many respects than any example of Neanderthal man so far found in Europe. Neither the geological nor the cultural age of Rhodesian man is fixed as yet, but we shall not over-estimate his antiquity if we make him a contemporary of the men who lived in Europe at the beginning of the Mousterian period. Neanderthal man became extinct, he was not transformed into modern man. In this respect Rhodesian man differs from him, he could stand very well as an ancestor to men of the Australoid type; he might be on the line along which modern races have evolved. To transform the Rhodesian into the Australoid type within the compass of the Pleistocene period demands a moderately rapid progress, to transform the Rhodesian type into that of the modern European in this space of time would require evolution to move at a rapid rate.

The important discovery which Prof. Dart has made at Taung, Bechuanaland, has no bearing on the problem we are discussing here. He has found the fossil remains of a young anthropoid ape; it is akin to the chimpanzee and to the gorilla. This discovery throws light on the history of anthropoid apes and upon their evolutionary proclivities, but not, I think, upon the pedigree of humanity.

I have stated the chief facts on which anthropologists have to base their judgment as to the rate at which man has come by the present characters of his body and brain. We are all agreed as to the primitive nature of the human types discovered at Piltdown, Heidelberg, Java and Rhodesia. There is also a broad agreement as to the early dates at which these types lived. If they represent the general stage which evolving humanity had reached in the opening phase of the Pleistocene period, then we must count that man's ascent to his present place has been one of rapid progress. On the other hand, we have the discoveries at Galley Hill and Clichy. The men found in those instances are of our type; if we accept the geological evidence, we have to presume that, so far as our ancestry is concerned, evolution has been stationary throughout the greater part of the Pleistocene period. As evidence accumulates, it becomes easier to reject the geological evidence relating to the discoveries at Galley Hill and Clichy, and more difficult to believe that man in his full-blown modern form could have been the contemporary of the uncouth types discovered at Piltdown, Heidelberg, Java and Rhodesia. In brief, the evidence which accumulates forces us to the conclusion that the evolution of man has been more rapid than many of us have hitherto believed.

I began by showing how much our anthropological inquiries are complicated by the rank degree of variability which prevails among all races of mankind. The same difficulty confronts us when we set out to search for our Pleistocene ancestry. The world of to-day is populated with races of the most diverse types. It was so in remote times, only the population was then sparse and scattered, and the racial types were infinitely more divergent than they now are. Of the early fossil types so far discovered only one—the Rhodesian man—has any claim to a place in the direct lineage of modern races. The stages which lead on to man of the Indo-European or Caucasian type have not been found as yet. It is not until we have unearthed these missing stages that we shall be in a position to pass a final judgment on the rate of man's evolution.

Current Topics and Events.

ON July 3 a deputation from the Australian National Research Council waited upon the Prime Minister of the Commonwealth to present a strong protest against acquiescence in the annexation by France of the Antarctic territory of Adélie Land, an action which was announced by French Presidential decree on November 24, 1924. On behalf of the Council, Sir David Masson (president) pointed out that since 1840, when d'Urville sighted and named, but did not land upon, Adélie Land, no attention has been given by France to this region. British expeditions, on the other hand, costing money and life, have made

important additions to scientific knowledge of what, from its geographical position, has come to be known as the "Australian Sector." On the Mawson Expedition of 1911-14, which added 1000 miles of coastline to the map, Australia has already spent 70,000/, and elaboration and publication of valuable results is still in progress. To no other country will further investigation of this sector be of such interest and significance. The progress of meteorological science, for example, will probably make the establishment of observing stations exceedingly important for Australia, for it must be remembered that Adélie Land, due

south of Adelaide, is nearer to Hobart (1467 nautical miles) than Hobart is to Perth. Economically, too, these lands must become of great value, and the framing and administering of laws regulating the exploitation of seals, whales, and other life in the neighbouring seas are matters urgently requiring attention. The question is whether France or Australia is the proper authority to take the required action.

THERE being no accepted international law in the matter of the administration of unclaimed polar territory, the Australian National Research Council urged the adoption of the principle applied by Canada in 1886 to Arctic lands. In effect this is that unclaimed polar lands should be administered by the most closely adjacent civilised Government. The assignment to Canada of the area between it and the Pole lying between the Canadian E. and W meridians of longitude, to Norway of Spitsbergen, and to Russia of Wrangel Island, are all in accord with the principle. So was the establishment of the Falkland Islands Dependency in the Antarctic under British rule, and of the Ross Dependency under New Zealand (July 30, 1923). It is now proposed that Australia should claim international sanction for the administration of the whole of that part of the Antarctic continent between 90° E. and 160° E., and it was pointed out on behalf of the deputation to the Prime Minister of the Commonwealth that, on the same principle, France would be justified in claiming an area lying to the south of her various island possessions in the southern hemisphere. The whole matter is arousing considerable interest in Australia, particularly in scientific circles, and it is hoped that the result of Government inquiries and action will be a friendly solution of the difficulty in accordance with the Canadian principle.

THE extending use of electricity in agriculture abroad has turned the attention of many supply engineers in Great Britain to the investigation of its possibilities, and a report on the subject has been published in the August Journal of the Institution of Electrical Engineers. The conditions which lead to an economic use of electrical power in farming are different in various countries. In Sweden, for example, the transmission lines from the waterfalls pass along the valleys in which the agricultural areas are situated. In this case, the lines can be readily tapped and the farmers supplied at a low price. In Holland, many lines are in existence traversing agricultural land on their way to supply towns or the electric pumps used for drainage purposes. In Switzerland also, the lines supplying the semi-domestic factories can be readily tapped. In France, however, the shortage of man power makes it necessary to use electric power, and military reasons make it advisable to maintain the agricultural areas at their maximum efficiency and make them as attractive as possible to the population, even at the expense of the State. In Italy, there is a superabundance of hydraulic power from the Alps in the summer time when the industrial demand is a mini-

mum and the farming demand is a maximum. Financial assistance is given by the State to rural distribution lines in Italy, Canada, and Scandinavia. In some of the districts abroad the supply is remunerative and some progress has been made in Great Britain. Most electrical engineers believe that the electrical equipment of all our main line railways is merely a question of time. When it is accomplished, there will be many distribution systems in existence from which a supply to agricultural areas could easily be given at remunerative rates. The cost of an overhead system to supply farmers is about 500/ per mile; this is mainly due to strict government regulations. In Sweden the cost is sometimes so low as 100/ per mile. It looks as if we would have to wait until the advent of electric traction before much progress can be made in applying electricity for the benefit of British agriculture.

THE opening meetings of the fifth Congress of the French Society of Chemical Industry will be held at Paris in the second week in October. As part of the proceedings, a special assembly will commemorate, on October 11, the one hundredth anniversary of the practical establishment of the soap industry by the French chemist, Michel Eugène Chevreul, who, in 1825, with J. L. Gay-Lussac, started a factory for the manufacture of stearic acid. Through his prolonged scientific researches Chevreul explained the process of saponification. The President of the French Republic, members of the Academy of Sciences, and those of kindred bodies will join in the forthcoming commemorative session. Born at Angers on August 31, 1786, Chevreul died in 1889, at the age of one hundred and three years. At seventeen Chevreul went to Paris, entering Vauquelin's chemical manufactory, ultimately he became director there of the laboratory. Later (1824) he took up the post of Director of the Dyeing Department and professor of dyeing at the tapestry works of the Gobelins. His well-known researches on the principles of harmony and contrast of colours were carried out at this period. In 1864 Chevreul was appointed Director of the Museum at the Jardin des Plantes, retiring in 1879. Elected a foreign member of the Royal Society in 1826, Chevreul was awarded the Copley Medal in 1857. The centenary of the birth of this distinguished chemist was celebrated in Paris with signal honour and many felicitous demonstrations. A great procession to the cathedral of Notre Dame took place on the occasion of Chevreul's funeral in 1889.

ACCORDING to a message dated August 24 in the *Times*, Capt. Amundsen's ship, the *Maud*, has returned to Nome, Alaska, in charge of Capt. Visting. It will be remembered that Capt. Amundsen set out in June 1922 with the *Maud*, intending to fly from Wainwright or Point Barrow, Alaska, across the Pole to Spitsbergen, and leaving the *Maud* to drift across the polar basin in the ice. Early in 1923 the position of the *Maud* was reported as lat 74° N, long 170° 30' E., and the most northerly point recorded is now stated to be lat 77° N, long 146° W. North-westerly cross-currents prevented the ship from

drifting across the polar basin. The party found that polar bears were numerous. As is now well known, Capt. Amundsen changed his plans for the polar flight and set out from Spitsbergen in May last, returning there on June 18 after having reached lat $87^{\circ} 44' N$, long. $10^{\circ} 20' W$.

WE welcome the appearance of a new German anthropological publication—*Zeitschrift für Völkerpsychologie*—which revives the title of a publication now defunct. It is edited by Dr. Richard Thurnwald, the well-known field worker and a sociologist of acknowledged merit. One of the objects of the new journal is to keep anthropologists in other countries, especially in England and in the United States of America, in touch with the latest results of continental work. It is even hinted that should the number of readers in England and the United States be sufficient, papers and reviews in English will be included in the contents. As an earnest of its international aim it may be mentioned that the editorial staff includes Dr. Malinowski, who is reader in social anthropology at the London School of Economics and Political Science, University of London. Should it be possible for the policy outlined by its editors to be carried out, the *Zeitschrift* should fill a serious gap. The loss by Germany of her colonies has brought about a serious curtailment of the sum total of the opportunities for and encouragement of anthropological research, which was a prominent feature in German public policy. The several annual expeditions fitted out by the Kolonialamt have necessarily ceased, and the publication of the *Mitteilungen aus den Deutschschutzbereichen*, the activities and publications of the Hamburg Institute, as well as of the many museums in the principal cities are now no more, or exist only in an attenuated form. It is not without misgivings that the British anthropologist views the disappearance in those territories now mandated of the official or officially encouraged study of the primitive populations. In this respect, however, the mandated territories are, unfortunately, in no different case from most of the dependencies of the British empire.

THE thirteenth annual meeting of the Indian Science Congress will be held in Bombay on January 4-9 next. Sir Leslie Wilson, Governor of Bombay, has consented to be patron of the meeting, and Mr. A. Howard, Director of the Institute of Plant Industry, Indore, will be president. The Congress will meet in nine sections, dealing with agriculture, mathematics and physics, chemistry, zoology, botany, geology, anthropology, medical and veterinary research, and psychology respectively. Papers to be presented at the meeting should be forwarded to the general secretary, S. P. Agharkar, 35 Ballyganj Circular Road, Calcutta, or to the president of the appropriate section, with a short abstract, not later than October 15, for submission to the Sectional Publication Committees, not more than ten minutes will be allowed for the reading of any paper. The local secretaries for meeting will be Prof. G. R. Paranjape, professor of physics, Royal Institute

of Science, and Principal A. J. Turner, Victoria Jubilee Technical Institute, P.O. Matunga, Bombay, to whom all inquiries as to accommodation should be addressed.

THE Soviet of Commissars of the U.S.S.R. decided on July 28 that, for all foreign visitors invited to the celebration of the bicentenary of the Russian Academy of Sciences, arrangements should be made for free travel on all the railways and waterways of the Union, for sleeping-cars on the direct communication routes, for seats, and for first-class cabin accommodation on all the sea and river steamers from August 15 until October 1. These facilities will depend on the production of a foreign passport, with the visa of the plenipotentiary representatives of the Union abroad, or of the general consulates of the U.S.S.R., with the inscription, "For the celebration of the Academy of Sciences." Besides free travel facilities, the production of a passport and visa thus inscribed will also obtain, without waiting, reserved seats in express trains, and luggage transport. These passports will thus be considered in the present case equal to the yearly certificates of members of the Central Executive Committee of the U.S.S.R. Special Reception Committees at the frontier stations (including Odessa) will meet foreign guests proceeding to the celebration as soon as they disembark, and assist in getting the necessary tickets or reserved seats without delay.

THE death on July 29, at the age of eighty-seven years, is announced of Prof. H. Hildebrand Hildebrandsson, the distinguished meteorologist who was formerly Director of the Meteorological Observatory at the University of Upsala.

WE much regret to announce the death on August 20, at the age of seventy-nine years, of the Right Hon. Sir George D. Taubman Goldie, K.C.M.G., F.R.S., who may be rightly regarded as the founder of Nigeria. When quite a young man, Goldie travelled extensively in Africa, and in 1877 visited the middle and lower Niger, where British traders had already secured a somewhat precarious foothold, depending on the caprice of the river chieftains. Goldie realised quickly the potential value of the region, and set to work to develop a system of government which would afford peace and security for both natives and traders, consideration of native rights being prominent, as in all Goldie's dealings with the negroes. By 1879 he had amalgamated the trading companies on the Niger into a single company, and two years later he applied unsuccessfully to the British Government for a charter which would have given the company practically sovereign powers. Goldie pursued his course in spite of this set-back, buying out in 1884 some French companies which had established themselves on the Niger. His efforts were rewarded in 1886, when the Niger Company was established, with Lord Abderare as governor and Goldie as vice-governor, after some four hundred political treaties with native chieftains had been concluded. Goldie's schemes were opposed to the aims of the German Colonial Society, backed by Prince Bismarck; but

British interests prevailed, and in 1898 Nigeria was secured to Britain. In 1900 the administration was taken over from the Niger Company by the Imperial Government, and Sir George Goldie took no further share in the administration of the country. Sir George was president of the Royal Geographical Society from 1905 until 1908, and was elected a fellow of the Royal Society in 1902.

THE June issue of the *Journal of the American Museum of Natural History*, New York, affords a good example of the means by which the Museum keeps in touch with its 8000 members, who receive the *Journal* bi-monthly as one of their privileges of membership. Of the nine articles, each of about ten or twelve pages, we have space to refer only to three or four. Prof. Ulric Dahlgren describes in clear, non-technical language the "ear" of a katydid situated in the tibia of the front leg, the structure of the tympana on which the sound waves impinge, and the nervous elements by which the impression is transmitted towards the brain. An article by the glass modeller of the Museum, H. O. Mueller, gives the reader a fair idea of the stages in the preparation of models of rotifers and Utricularia which are excellent examples of his technique. Dr. E. W. Gudger brings together a number of instances of spiders attacking and feeding upon fishes, frogs, lizards, birds, and small mammals, and Dr. W. G. van Name in "an instance where evolution has turned backward" gives a readable account of ascidians. The illustrations are, as is usual in the *Journal*, beautifully reproduced, and include a series by Dr. R. W. Miner representing some of the groups of invertebrates exhibited in the Darwin Hall of the Museum, e.g., as seen on the sea bottom in Vineyard Sound, in a tide pool, on wharf piles, and in sand.

THE Geological Survey of the Union of South Africa has just issued *Memoir No. 19* on the Inland Coalfields of Natal, by W. J. Wybergh. This memoir describes the three important coalfields of Natal, the Klip River coalfield, the Vryheid coalfield, and the Utrecht coalfield, giving descriptions in each case of the general surface contours, of the geology of the field, the general analyses and commercial qualities of the coal of the various seams, and finally an attempt to estimate in each case the available coal reserves. The available information concerning the three fields differs considerably, the first named having been quite largely worked and relatively well explored, whilst very little has as yet been done upon the last of the three, although this may well prove to be the most extensive of any. The memoir is illustrated by sketch sections and maps, and constitutes the most complete source of information respecting Natal coalfields which has hitherto been published.

THE Report of the Survey of India for 1923-24 records a considerable increase in the topographical survey of the year, 65,673 square miles being surveyed, an increase of some four thousand square miles compared with the previous year. About 41 per cent of the whole topographical survey has now been

completed. Aero-photo surveys were undertaken in the Irawadi delta and in Waziristan. During the year, 187 one-inch topographical sheets were published, and it has now been decided to treat this series as the tactical map of India, in place of the half-inch series. One new sheet of the international "one million" map was published, making 13 sheets now available. Of the useful maps of India and adjacent countries on the one-million scale, no new sheets were published during the year. Two new sheets have appeared in the Southern Asia series, on a scale of one to two million. The report contains full indexes to all the survey maps.

THE British Museum has recently issued a guide (price 1s.) to the collection of fossil plants in Gallery X in the Department of Geology and Palæontology. This guide, which was originally drawn up by Mr. H. Hamshaw Thomas just before the War, has now been revised by Mr. W. N. Edwards, assistant in the Museum, and with its 6 plates, folding-chart of geological strata, and 70 pages of letterpress with 40 text figures, must be regarded as very good value. The guide is simply and concisely written, and concentrates attention mainly upon features which can be seen in plant impressions and without reference to the microscope, though important efforts at reconstruction of long extinct plant types from the scattered material in the rocks are elucidated with the aid of diagrams, some new, some already well known to the student. It may be hoped that this guide will make more accessible, and therefore better known, the palæobotanical resources of the Museum, which include more than 5500 microscope slides from the historic collections of two English investigators, W. C. Williamson and Dr. D. H. Scott.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: Secretary to the Medical Society of London—The Acting Secretary to the Society, 11 Chandos Street, W. 1 (September 4). Inspectors under the Ministry of Agriculture and Fisheries for the purposes of the Diseases of Animals Acts, 1894 to 1922—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S. W. 1 (September 7). Two analysts for the building research station of the Department of Scientific and Industrial Research—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S. W. 1 (September 14). A junior assistant physicist at the building research station of the Department of Scientific and Industrial Research—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S. W. 1 (September 14). A preparator in the herbarium of the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S. W. 1. A pathological laboratory assistant in the Agricultural Department of the Government of Kenya—The Crown Agents for the Colonies, 4 Millbank, S. W. 1 (quoting M/13369). A lecturer in entomology, botany, etc., at the Royal Agricultural College, Cirencester—The Secretary

Research Items.

A MAGDALENIAN STATION IN SWITZERLAND—Dr Fritz Sarasin and Dr. H. G. Stehlen describe in the *Denkschriften der Schweizerischen Naturforschenden Gesellschaft*, Bd. 61, the results of explorations of a Magdalenian rock shelter at Ettingen near Basel, undertaken in 1918, 1919 and 1922. The latter deals with the animal remains, the former gives an account of the excavations and describes the archaeological finds. The uppermost stratum consisted of 1.20 to 1.40 metres of brown earth in which were fragments of human bones, bones of recent animals and potsherds belonging to recent, Roman and neolithic times, but no flint implements. The stratum immediately beneath contained no traces of human occupation, but remains of Magdalenian type were found in the two strata below, the first flint implements occurring in the upper of these two strata at depths of 2.50 to 2.70 metres. The implementiferous deposit continued into the lower stratum, the total depth of the deposit being about 50 cm. at its maximum. The implements found included a number of knives and spear-heads of flint, a doubtful implement of limestone, and an implement made from a long bone, 50 mm long with a spatulate-shaped end.

THE AGE OF THE PADMA—Vol. 20, No. 1 of the *Journal of the Asiatic Society of Bengal* contains an interesting note by Bisvesvar Bhattacharyya on the date at which the waters of the Ganges, which it is known originally flowed to the sea through the channel now indicated by the Bhāgirathi, the Hoogly and the Tolly's nullah, were diverted eastward into what is now the Padma. It is usually assumed that this was caused by a diversion in the course of some northern rivers which took place about the sixteenth century. References in Bengal literature, however, support an earlier date. Thus a copper plate inscription of Srichandra Deva from South Faridpur recording a grant of land shows that in the tenth-eleventh centuries the Padma flowed through that district but not as a considerable stream, while from a poem by Dhoyi, who flourished in the twelfth century, it may be inferred that the Bhāghurati was then a mighty river. In a poem believed to be of the fifteenth century—the *Rāmāyaṇa* of Kṛttivasa—there is a legend recording that a sacred goddess was taken away through the Padma and brought back through the Bhāgirati, which may be a traditional reference to the diversion of the waters of the sacred stream. The Vaisṇava literature shows that by the end of the fifteenth century the position of the Bhāgirati as an important river had gone. It would appear, therefore, that the diversion of the waters to the Padma must have taken place in the fourteenth if not in the thirteenth century.

GROWTH AND SPAWNING OF SALMON—Mr. W. L. Calderwood has given data on the growth of the salmon (*Proc. R. Soc., Edin.*, vol. 45, No. 13, 1925). He emphasises the great amount of growth which takes place during the first summer of sea-feeding, often continued during the second summer in the sea. Two years commonly elapse before the first seaward migration of the smolt, and such a fish, after spending a year and a varying number of months in the sea, has grown to about three times what its length was when a smolt, and now as a grilse it returns to the river. Other fish have spent two or three years in the sea; these, with two years of early life in the river, are therefore five years old; and still others have spent a further year in the sea, and, not having lost weight by leaving their feeding grounds and spawning, they are of great size. Mr. Calderwood states that all fish more than 50 lb weight are males, and that during his twenty-five years' experience of Scottish salmon fisheries, he has known only two cases of

females more than 40 lb in weight, and both fish came from the river Lochy, one weighed 43 lb. and the other 48 lb. He asks why it is that the salmon which enter the streams of outlying islands, e.g. Lewis, Mull, Skye, and those of small and rocky catchment areas on the mainland are always small, and suggests that it is because of the poor river-feeding for the parr and smolts in those barren grounds. Another feature of the salmon of these small Highland streams is that they return to spawn more frequently than do the fish of the larger rivers. In the river Add in Argyll, fish have been found with three and four spawning marks, and one kelt showed four spawning marks and therefore had spawned five times, which appears to be a unique case. Of all the salmon scales examined by various investigators, only eight which show four spawning marks are recorded—two from the St. Lawrence, four from the Add, one from the Conon, and one from Loch Maree.

CLYDE PLANKTON—Miss S. M. Marshall has studied the plankton of the Clyde for the years 1923 and 1924, and has summarised the principal results (*Proc. R. Soc., Edin.*, vol. 45, No. 12, 1925). The general course of events was the same in both years and is similar to that found at other stations. There is a winter minimum followed in early spring by a large increase in the number of diatoms and of larval forms, e.g. of copepods, cirripedes, and molluscs. This is followed in May and June by a period poor in diatoms but rich in crustacea. July, August, and September are the months richest in variety—diatoms are abundant, peridinians reach their maximum, larvae of all kinds are numerous, as are also medusæ and sagitta. The autumnal diatom maximum is in August or September, after which the number and variety of planktonic organisms decrease. The first part of the paper deals with the organisms in systematic sequence, noting their relative abundance at various seasons, while the second part is a summary of the plankton month by month in 1923.

THE SANTA BARBARA EARTHQUAKE—A short article on the Santa Barbara earthquake by Dr. Bailey Willis, the well-known student of Californian earthquakes, is published in *Science* for July 10. Dr. Willis was in Santa Barbara when the earthquake occurred, and states that it was a moderately severe, but not a very severe, earthquake. That it was much slighter than the Montana earthquake which occurred thirty-six hours earlier is clear from the fact that it was felt in only four counties in California, while the Montana earthquake disturbed four States. The Santa Barbara earthquake, Dr. Willis considers, was due to a movement of a fault that runs along the Santa Inez range of mountains, the movement being from south to north. As each of the four great faults of southern California has produced an earthquake during the last seven years, and as the last great earthquake of the Santa Barbara region occurred in 1857, an earthquake there was expected by American seismologists, and the prevailing feeling seems to be one of relief that it was not more serious. It was known that a strong pressure is being exerted against the Santa Inez range from the south, as Gaviota Peak, a triangulation point of the U.S. Coast and Geodetic Survey, has been thrust 24 feet northward in thirty years.

RIVER GAUGING—A pamphlet entitled "River Gauging" has recently been issued by the Department of Scientific and Industrial Research, being a Report by Dr. M. A. Hogan on methods and appliances for use in Great Britain (London: H.M. Stationery Office, 1925, 2s. 6d. net). As a review of the present state of knowledge on a complex and difficult operation, the publication is an exceedingly interest-

ing and serviceable compilation. It was prepared for the Committee on Gauging of Rivers and Tidal Currents, and the conclusions arrived at are endorsed by them and embodied in their report. Very briefly, the general conclusion is that methods and instruments for gauging are available and adequate for the needs of a hydrometric survey. In detail, for gauging small streams, some form of measuring weir is suggested with an automatic recorder. For large streams with natural flow, the discharge can be expressed as a function of the water level, provided the bed of the river does not alter its character; the curve representing this function in any given case can be drawn from measurements of the discharge by a current meter—this is known as the "stage-discharge" curve. For large streams artificially regulated, the stage-discharge method is useless, but measurements can be made by calibrating a weir by a combination of model experiments and current meter measurements. The most generally useful type of meter on the market is stated to be the small Price meter, as used in the United States. This meter has proved reliable and convenient where the velocity of flow is not less than half a foot per second and there is no undue turbulence. "Where turbulence exists," it is advisable to take readings both by the Price and screw type meters. "Under turbulent conditions," a propeller meter with a guard ring, such as the Stoppani, should be used, as this type is subject only to small error when measuring oblique velocities.

ATMOSPHERIC POLLUTION.—The tenth report of the Advisory Committee on Atmospheric Pollution which has recently been issued by the Meteorological Office, Air Ministry, shows continued activity on the part of this body during the financial year 1923-24. The report is divided into eight sections, three of which deal with methods of measurement of atmospheric pollution which have now become well established. These are: (1) the standard collecting gauge which measures the impurities brought down by rain, (2) the automatic filter which gives a semi-continuous record of the amount of impurity in the air, and (3) the dust counter. The remaining five sections are devoted to more recent developments of the work. Of these, the research into the effect of atmospheric pollution upon visibility is drawing to a close. A close connexion has been found between the amount of impurity as measured either by the automatic filter or by the dust counter and the percentage transmission of light through 50 feet of air. It is probable that the relationship would be even closer were it not for the presence of small water drops in the air in foggy weather. These drops affect the visibility but not the pollution measurements, and no satisfactory means of measuring their number has yet been found. Some useful measurements of dust in the upper atmosphere taken on aeroplanes are recorded from America, but it has not yet been found possible to obtain records in Great Britain, though it is hoped the difficulties in the way may be surmounted shortly. In two other sections a new dust counter for use in exceptionally dusty atmospheres is described, and the darkness of January 23, 1924, in London, when a high fog of unusual intensity prevailed, is discussed in some detail. It is noted that records from one or two additional standard collecting gauges are still needed in country districts, though urban areas are well represented. It may be hoped that this need will soon be met.

WEATHER AT FALMOUTH.—Meteorological notes and tables for the year 1924 prepared by Mr. J. B. Phillips, superintendent of the Falmouth Observatory,

have just been issued. Many features of general interest have been brought out in the notes by the author. Temperature comparisons are made with other stations reporting to the Air Ministry which show Falmouth to enjoy a generally mild winter. The mean air temperature for the year was $51^{\circ} \cdot 2$ F., which is $0^{\circ} \cdot 5$ warmer than the normal for 50 years; the coldest month was February with a mean $41^{\circ} \cdot 5$, the warmest, July with $59^{\circ} \cdot 5$. The absolutely highest temperature was 69° in August, and the lowest 27° in February. The duration of bright sunshine in 1924 was 1597 hours, which is 156 hours less than the normal for 40 years; the brightest month was July with 208 hours, and the months with least sunshine were January and December with 59 and 60 hours respectively. There was a great preponderance of winds from south and west, these directions occurring on 238 days, while north and east winds blew only on 128 days. The total rainfall for the year was 58.08 inches.

CINEMATOGRAPHY IN COLOURS.—The Keller-Dorian method of cinematography in colours is described by M. A. Troller in *La Nature* of August 1. A colour filter is inserted between the components of the lens, which is divided into two equal segments with a parallel-sided strip between them, each of the three spaces thus provided being coloured with one of the three primary colours. The film has impressed upon the back of it closely packed lens-like projections, at the rate of about thirty to forty to the mm., and this side is turned towards the lens, so that each of the lenticular projections on the film gives a minute image of the tricoloured filter on the sensitive surface. For projection the arrangement is the same, but the direction of the light is reversed. To produce the projections on the back of the film, a skilled engraver working under a microscope cuts an original, and from this a suitable steel roller is prepared, which is mounted with an ebonite roller, so that the film may be passed between them. The steel roller is electrically heated to 100° C. to soften the base of the film, and enable it to take the impression.

XENON HYDRATE.—A hydrate of argon was discovered by P. Villard in 1896, and M. R. de Forcrand announces in *C.R. Acad. Sci.*, Paris, July 6, that he has prepared xenon hydrate by compressing the gas, with a trace of water, in a Cailletet apparatus. He had already found a crystalline hydrate of krypton, with the probable formula $Kr + 5H_2O$, in 1923; but the xenon hydrate is produced much more easily, only a few atmospheres being required to coat the walls of the tube with a kind of hoar frost, without the application of ice. At temperatures in the neighbourhood of 0° C., this remains intact when the pressure is only a little above that of the atmosphere. A table gives the heat of formation, starting with liquid water, at a series of temperatures and pressures ranging from 14° C. and 1.45 atm. up to $23^{\circ} \cdot 5$ and 17.00 atm., the mean value being 18.266. At and above 24° C. the hydrate is not formed even with very high pressure; the corresponding temperature for krypton is 13° . It is found graphically that the dissociation pressure of one atmosphere corresponds to a temperature of -0.13° . The calculated number of molecules of water to one atom of xenon is 6.6, that is to say, that there are 6 or 7 molecules of water in the hydrate. The dissociation pressures at 0° C. are 1.15 atm. for xenon, 1.45 for krypton, and 98.5 for argon, a hydrate of neon has not been obtained even with 260 atm. at 0° C. Thus the stability of the hydrate increases with the molecular weight of the gas, and this is also shown by the heats of formation of the hydrates.

Carnot's Cycle and Efficiency of Heat-Engines.¹

CARNOT laid down the great and incontrovertible principle that if, when we have obtained motive power by the application of heat, we inquire whether we have obtained the maximum of motive power from this application, we can answer this question by ascertaining whether by applying the same amount of motive power in reversing the process of expansion, or expansion and contraction, in the course of which we have obtained motive power, we can bring the working substance back to its starting-point. When the process is reversible in this manner, we have obtained the maximum possible output in motive power, whatever be the nature of the working substance, gaseous, liquid, or solid.

Carnot thus furnished a criterion by applying which we could judge of the efficiency of a heat-engine. Unfortunately, however, he failed in applying that criterion correctly. His unsuccessful attempt was, however, a great one, since it has continued to mislead scientific men, and confuse engineers, for now more than a century. Carnot invented the famous Carnot cycle, the bugbear of generations of students, and with it an argument to the effect that it is the most efficient cycle possible in the mode of action of a heat-engine.

It is evident that in the cycle described by Carnot, much of the heat taken up from the source in the second stage (isothermal expansion) is thrown away into the condenser in the fourth stage (isothermal compression). This is apparently a waste of heat energy. It is only in the second and third stages of the cycle (namely, isothermal expansion and adiabatic expansion) that work is done on the engine, or motive power is, to quote Carnot's expression, gained. It is, therefore, at the end of stage three that we must apply Carnot's test. When we do so, and simply re-compress the air to its starting volume, we find that much more work has to be done on the air than was done by it during the second and third stages of the cycle. We have, therefore, in stages two and three of the Carnot cycle expended heat which could have been converted more completely into mechanical energy if we had employed adiabatic expansion; and this waste has evidently occurred in the isothermal stage of expansion, since the third stage is in each case adiabatic.

We thus see that the Carnot cycle is radically inefficient. A great deal of heat is transferred quite uselessly from the source to the condenser, and thus wasted. To obtain from the heat communicated to the air in the cylinder the maximum of work on the engine during the expansion, we must quite evidently make the whole expansion adiabatic, while to reduce to a minimum the corresponding work done by the engine in the compression stage, we must make the whole of the compression isothermal, thus throwing away as much heat as we can with the condenser at its existing temperature.

It is evident that by eliminating altogether the effects of atmospheric pressure, we could at once obtain fifty per cent. efficiency in the cycle of an ideal heat-engine. This is accomplished in the ideal cycle of a steam-engine working with complete adiabatic expansion of the steam down to the pressure of the aqueous vapour in the condenser. In this case the cylinder would be enclosed above, and would contain at the start nothing but aqueous vapour at the pressure corresponding to atmospheric temperature, except for a little water in the space below the piston.

In stage 1 the water would be evaporated before the piston was allowed to move. In stage 2 the steam would expand adiabatically, doing work on the engine, until it reached the pressure of the aqueous vapour above the piston. In stage 3 the piston would return to its original position without any net work being done by or on the engine, and the steam not already condensed would condense again to water. Half the heat applied would be spent almost entirely on the engine during expansion, and the other half would pass into the condenser as the piston returned. The efficiency would thus be practically fifty per cent.

We can see now that the percentage efficiency of a heat-engine, or at any rate of a steam-engine, provided that the expansion is adiabatic and complete, and the compression isothermal, does not depend at all on the difference between the initial and final temperature during the expansion. We can quite evidently obtain just the same percentage efficiency with a small as with a great difference of temperature. On this point we are running counter to cherished academic doctrines and to authority which has been generally accepted for more than seventy years, but that authority rests upon the quite mistaken conclusion that the Carnot cycle is one of maximum efficiency within a given interval of temperature.

Let us now look more carefully, and at the same time from a wider point of view, at the reason why more than fifty per cent. efficiency is impossible in a heat-engine. In the case of the air-engine starting from atmospheric pressure and temperature, it is the atmospheric pressure which limits the stage of expansion. The air can no longer expand and do external work after its pressure has fallen to that of the atmosphere pressing on the upper side of the piston. Now the pressure of the expanding air falls in accordance with Boyle's law in proportion to its relative increase of volume, but the work done during adiabatic expansion, and consequently the fall in absolute temperature of the expanding gas, depends also on the pressure, and therefore proceeds also in proportion to the relative increase in volume. The air in the cylinder can only exist in the expanded state at the existing pressure in virtue of an increase of absolute temperature proportional to the increased volume. This follows from Charles's law. Hence, assuming Charles's law, for every degree of temperature lost by the air in expansion, the air in the cylinder must be a corresponding degree above the atmospheric temperature which it had before heat was applied to it. When the temperature of the expanding gas has fallen by half the amount to which it had been raised, this condition is no longer possible, and the air can no longer expand against the atmospheric pressure. Half the heat has gone in external work, and half remains in the expanded air, and must be thrown away if the air is to be brought back to its original state with the help of atmospheric pressure alone.

The conception of the Carnot cycle, with its extraordinary peculiarities, was quite evidently based, not on the study of actual heat-engines, but on Carnot's ideas, derived from the caloric theory, of how a heat-engine works. These ideas led him to the conclusion that in the working of a heat-engine, any change of temperature in the working substance, unless the change is accompanied by change in volume, is a waste of heat. Hence the strange feature of the Carnot cycle that in it there is no change of temperature without change of volume.

As we have already seen, the whole of the expansion and none of the compression must be adiabatic

¹ Abstract of a paper on "The Maximum Efficiency of Heat-Engines and the Future of Coal and Steam as Motive Agents," read before the Institution of Mining Engineers on June 16 by Dr J. S. Haldane, F.R.S.

in a heat-engine working with maximum efficiency. There must also be one and only one stage in which abrupt change of temperature occurs without change of volume. In the steam-engine with maximum expansion of the steam, there is abrupt rise of temperature at the beginning of the cycle. If, as in the Watt-Newcomen engine, there is also abrupt fall of temperature before expansion is complete, loss of efficiency is a necessary result.

At the present time steam-engines and oil-engines are running a neck-to-neck race as regards many employments, while elsewhere the oil-engine is everywhere being applied for quite new purposes, where no heat-engine had previously been applied. In the opinion of many persons the steam-engine is bound to be displaced more and more by the internal-combustion engine. This opinion is largely based on the current academic doctrine that the efficiency of a heat-engine depends on the absolute temperature reached in the engine. In the present paper the academic teaching has been thrown to the winds, backed though it be by the names of men to whom the whole world has good reason to be grateful. A step further may also now be taken. We suggest that the development of the steam-engine has been very greatly hindered by the fallacious teaching associated with Carnot's cycle. Engineers have been prevented from seeing clearly what the maximum efficiency of a heat-engine is, where that efficiency is being needlessly lost, and how the steam-engine can be modified to suit varying circumstances without loss, or with minimum loss, in efficiency.

We still use furnaces and boilers which waste much heat whenever an engine is temporarily out of action or doing only light duty, even though they may be so designed as to cause very little waste, during continuous full duty of the engine. It seems probable that the furnaces and boilers of the future will be gas fed, the gas being formed in a heat-insulated producer or carburettor, and only made and burnt as the steam

is required, the whole regulation being mechanical and the heat of the waste gases being nearly all returned to the furnace and boiler. Another alternative presenting similar advantages is the use of pulverised fuel. The boiler and furnace can then be made much smaller than is now usually the case.

As regards modifications of the steam-engine to suit varying circumstances, it seems that small engines, working at very high pressures, and with correspondingly small tubular boilers, will come more and more into use. A steam pressure of 100 atmospheres, with a corresponding temperature of 600° F., seems well within reach. At such a pressure the percentage loss of efficiency, owing to either the discarding of a condenser or condensation at or even somewhat above boiling-point, would not be too large. The bulky apparatus required for complete expansion can thus be dispensed with, reducing the engine to extremely compact proportions and very small weight. By these means the steam-engine can be rendered far more compact and adaptable to varying conditions under which only internal-combustion engines, or steam-engines without a condenser, are now used.

Perhaps too sanguine a view is taken of the future of the steam-engine, but it seems that in every case where either fuel economy or size of engine is of predominating importance, the steam-engine and coal will in the future displace the internal-combustion engine and oil. Even where oil or gas is alone desirable or available as fuel, it will probably turn out to be cheaper, where fuel economy and weight of engine are important, to use them as fuels for steam-engines. The latter will probably take the place of internal-combustion engines in even motor vehicles and aeroplanes. With the further development of electrical transmission of power obtained from coal and steam, the steam-engine and coal will also come more and more to the fore.

The Motion of Whales during Swimming.

By Dr. C. G. JOH PETERSEN, Director of the Danish Biological Station, Copenhagen

IN our two well-known Danish zoological handbooks it is stated regarding the swimming of whales, in one that "It is the screwing actions of the hind part of the body (the tail) which force the whale through the water, the tail fin acting only to balance up and down," in the other that "The whales move in the manner of fish by flapping the tail from side to side", according to a verbal statement, this was observed by the author himself on porpoises in a tank in the Zoological Garden. In the foreign literature I have found information¹ that whales, when swimming rapidly, move the tail fin up and down; when they swim slowly, on the other hand, they perform screw-like motions. Porpoises have been observed in tanks in England to swim by moving the tail fin up and down with slight undulations to each side.

Thus there seem to be greatly divergent opinions as to the manner in which whales effect their swimming movements. I have myself seen dolphins following, *e.g.*, the steamship of the Biological Station, and I have spoken with many others who have seen the same; we are agreed that it is impossible to see how they swim; they only tremble, but follow, apparently with ease, the largest steamship going at full speed.

In the spring of 1924 I was by chance present at a catch of porpoises in the Bramsnæs Vig (by Holbæk),

and there I bought the tail of a porpoise just caught. Dr Blegvad, the assistant of the station, and I dissected it, Fig. 1 is a sketch of the result. At the base the tail fin is very flexible, so long as it is in a fresh condition, similar to the carpus of the hand of man. The vertebræ here are very flexible in relation to each other, and the vertebral column extends right out to the posterior edge of the fin. No muscles are found in the tail fin itself, only four strong tendons extending right out to the extreme vertebræ. These tendons may move the horizontal fin up and down, but scarcely with any force, and doubtfully sideways. The flukes of the tail fin consist only of epidermis and fibrous tissue, they are somewhat elastic for movements up and down. Of other muscles in the tail (hind part of the body), there are two for lateral motions and two for vertical motions; they terminate with strong tendons some distance from the root of the tail fin.

The tail fin with its vertebræ may thus be moved up and down by bending at the root, but these movements do not seem to produce force enough for powerful swimming, because, amongst other reasons, the flukes will impede the speed considerably when in their extreme positions. One can well imagine that quick movements of the flukes towards the horizontal position may give a small speed, as when a rudder is moved in a little boat; this produces a slight speed, if the motions towards the central

¹ Beddard, "A Book of Whales," London, 1900, Murie, "On the Anatomy of a Fin-Whale," Proc. Zool. Soc., 1865; T. Bell Pettigrew, "Animal Locomotion," London, third edition, 1883

position are the strongest. But if we imagine that the extreme part of the tail (the hind part of the body) itself is moved up and down, even if these movements are only slight, the elastic fin would be enabled to take up suitable inclined positions for up-and-down movements and thus give effective power during the full extent of the motion (Fig. 2).

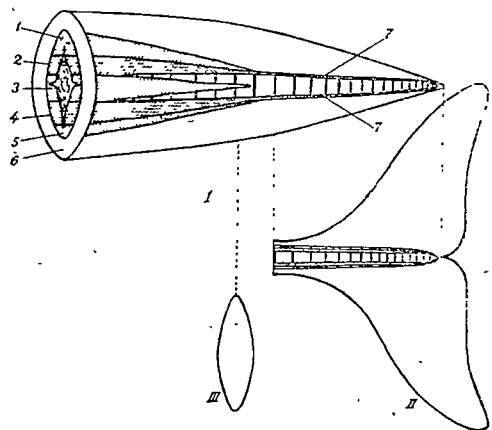


FIG. 1.—Combination of a vertical, transverse section and a vertical, longitudinal section through the tail of the porpoise. I, Dorsal muscle; 2, the two upper tail fin muscles; 3, the two lateral muscles; 4, the two lower tail fin muscles; 5, ventral muscle; 6, layer of blubber; 7, left upper and lower tail fin tendon. II, The tail fin seen from above, with its two upper tendons and the vertebrae denuded. III, Transverse section through the tail.

In order to try this, I had a thin steel plate made, shaped like the tail fin of a porpoise, and attached it to a vertical stick; when this stick was moved up and down in the water at a suitable speed (rhythm) the plate produced a powerful current rearward, simultaneously forcing the stick forward, against the edge by which I supported it. The steel plate I employed was too thin and flexible for a continuation of these experiments; for I could only "swim slowly" with it, and to procure a stronger one took so long, that I was not able to proceed further; but the experiment had proved, without doubt, that by means of small movements up and down of the terminal part of the tail, the tail fin of the dolphin may be employed as an excellent means of propulsion, inasmuch as its muscles (tendons) may give it the correct rigidity, corresponding with the varying speed through the water; in this the operations of the four named muscles and tendons surely may be sought. When the dolphin starts swimming, large movements are required to move a sufficiently large quantity of water, but, when speed is once gained, the water will be felt hard, and then only small but quick motions up and down, with more force and more rigidity in the tail for each stroke, are required. Dolphins are said to be able to follow destroyers up to a rate of about 30 knots, *i.e.* at the same speed as fast trains go between Copenhagen and Korsør.

It is the great drawback in all steamship propellers that their mould cannot conform with the variation in speed, and that they are quite without elasticity; they yield, therefore, only a comparatively small effective power. Mr. Vogt, an engineer, has endeavoured with the pendulum propeller to produce a variable pitch by means of a complicated system of springs (metal springs), and he really succeeded in this; but the construction seems to have been too expensive to make use of practically.

By means of the elastic and flexible structures of which the tail fin and the tail of the porpoise are made it is, on the other hand, possible to obtain an enormous effective power by comparatively few and

small movements; thus there is no need for astonishment that this little fin is really able to give such a high speed to the big animal. Mr. Vogt, with whom I have debated this matter, agreed fully with me on this point, as well as, on the whole, with my views upon this matter.

The objection may be raised to this illustration of the swimming movements of the whale, that the movements up and down of the tail itself must evidently impede the speed through the water; but the tail of the whale is, as a rule, so compressed in the terminal part that the resistance offered is considerably diminished, and, furthermore, it refers only to small, vertical movements.

As is well known, many fishes swim by performing lateral movements with the tail, because the fin is set vertically, *i.e.* on the same principle as the motions of whales, which only move the fin up and down, because this is situated horizontally; that fish in addition to these movements may also perform screw-like motions, is also well known from seeing goldfishes in aquaria. But they do this only when swimming slowly; if speed is desired, it is gained by means of strokes from side to side, analogous to the up-and-down strokes of the whales.

It is now easily understood why many people, including myself, who have observed dolphins following steamships during speed, have seen nothing but a trembling of their bodies, because the movements of the tail and the fin are up and down and comparatively slight, and vertical movements are not easily observed from above. Had there been sideways or screw-like motions, they could not have escaped the observer; that such movements also may be performed by whales, I do not doubt, but they occur only during quite slow movement, when the whale feeds, or when for some other reason it is in no hurry.

When, especially from observations of porpoises in tanks, lateral motions of the tail are mentioned, or

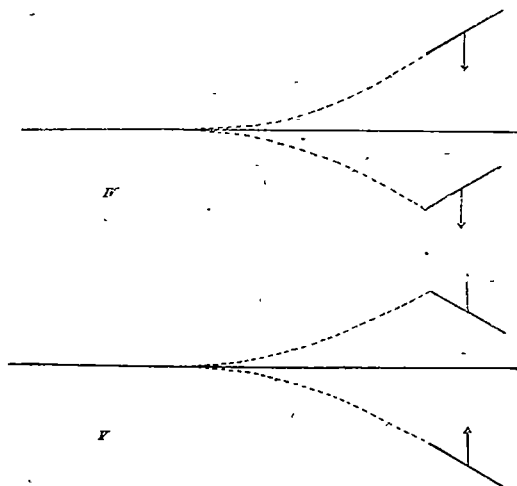


FIG. 2.—The positions of the tail fin (IV) during downward movement of the tail, (V) during upward movement of the tail.

that the tail is used in a fish-like manner by strokes from side to side, this evidently arises from the fact that here the animal the whole time had to steer in order to avoid running against the sides of the tank. The observations themselves undoubtedly are correct. But statements to the effect that the tail fin is exclusively used for steering up or down are false; it may be used for this, and certainly also for steering sideways, but the flukes of the tail fin are the proper

organs for propulsion of the whale, as the propellers are in a ship, and the importance of the tail (hind part of the body) corresponds to that of the ship's engine which moves the propeller.

If we compare the size of the propeller of a steamship with the size of the ship, the propeller seems small, and still it may, in spite of its slight effective power, propel the ship, the tail fin of a dolphin or a whale is not smaller in comparison with the size of these animals than the propeller of the steamship, but larger, if anything. Thus, bearing in mind the obviously far greater effective power of the fins of

the whales, it is not to be wondered at that these animals may follow the biggest steamships with ease, and even follow our quick destroyers; in fact, a harpooned whale may carry away a steamship with great velocity through the water, in spite of the steamer backing full speed with its propeller.

I have presumed that the anatomy of the tail and the tail fin is mainly the same in the porpoise as in the other whales, this, however, as well as so many other things concerning this matter, I must leave to others, who may get an opportunity to examine it more closely.

Physics in Radiology.

SEVERAL notable papers were read before the Physics Section of the International Congress of Radiology, which was held at the Central Hall, Westminster, on June 30-July 4. The work of the Congress began with a joint discussion, in which the Physics and Radiology Sections met for a full day's consideration of the difficult problem of X-ray measurement. This discussion was opened at 10 A.M. on July 1 before a large attendance, by Sir William Bragg and Dr. Becquerel, the president (Dr. T. Holland) occupying the chair. The importance of such a discussion, in which representative men from practically all over the world took part, is obvious, and it is satisfactory to be able to report that the practical outcome has been a definite proposal as to the mode of initiating the formation of an International Committee to deal with the matter.

Sir William Bragg dealt generally with the importance of physical measurements and referred to the difficulties already met with in determining the brightness of light. He pointed out that the X-ray problem has special added difficulties of its own. First comes the question of a unit, and then the production of standards to be expressed in terms of the agreed unit, and finally it remains to ascertain what biological effects are associated with certain rays, or groups of rays, so measured. He was hopeful that a successful issue will ultimately result from the efforts now being made throughout the world towards setting up a suitable system of X-ray measurement, but he warned his hearers that the question of an X-ray unit is beset with more difficulties than have ever been met with in the case of any other unit which science has been called upon to devise. Finally, he directed attention to the principles which must underlie such a system, and set the problem clearly before the meeting.

Dr. Becquerel, of Paris, spoke more in detail with reference to the conditions which the medical radiologist has to face, referring to the pioneer work of Villard, and discussing the actual methods of measurement suggested by Solomon, Kronig and Friederich, Seit and Wintz, and others. He made an eloquent appeal for international unity in regard to the question of X-ray measurement.

On the conclusion of the formal opening of the discussion, the chairman of the Physics Section (Major C. E. S. Phillips) presided for the rest of the day. In the course of his remarks, Dr. Becquerel strongly urged the setting up of an International Committee to deal with X-ray measurements, and Dr. Finzi, who spoke later, also directed attention to the matter and seconded Dr. Becquerel's proposal, which on being put to the meeting was carried with enthusiasm.

Dr. Becquerel was followed by Dr. Solomon (France), Dr. Behnken (Germany), Prof. Grebe (Germany), Dr. Altschul (Czechoslovakia), Dr. Shaxby (Cardiff), who read a communication from Dr. A. Dauvillier

(France), Dr. Finzi (London), Dr. Moore (London), Prof. Wintz (Germany); Dr. Reyjeski (on behalf of Prof. Dessauer), Dr. Glasser (U.S.A.), Prof. Friederich (Germany), Dr. Mallet (France), Dr. Holdfelder (Germany), Prof. Holthausen, Dr. Coliez, Prof. Crowther (Reading), Prof. Russ (London), and Dr. Ernst (U.S.A.). The chairman directed attention, at the conclusion of the discussion, to the principal points raised, and emphasised the desirability of taking steps towards the establishment of an International Committee to pursue the subject.

On Wednesday evening the Silvanus Thompson Memorial Lecture (inaugurated by the Röntgen Society) was delivered (in English) by the Duc de Broglie, and attracted an enthusiastic audience. The nature of the secondary radiations set up by X- and gamma rays, and attempts to understand the process by which they are initiated, are matters of great importance and interest to radiologists generally, and especially to those searching for clues as to a biophysical explanation of the effects of radiations upon tissues. The Duc de Broglie eloquently summarised our present knowledge of this subject, and gave a valuable account of some recent researches by French physicists who have been extending the work begun by Rutherford, C. T. R. Wilson, Ellis, and others, relating to the problem. At the conclusion of the lecture the Silvanus Thompson Memorial Medal was handed to the Duc de Broglie by the president.

On Thursday morning an interesting paper on the radiography of coal was read by Mr. Norman Kemp, and Dr. Bouers then described a new metal X-ray tube (Metalix) for use in radiography and X-ray therapy. This was followed by an important paper by Prof. Friederich (Freiburg) in which some new results were described. The last paper of the morning was read by Dr. Koopman, of Amsterdam, who showed a novel type of Potter-Bucky diaphragm. The variety and originality of these papers were striking, and interesting discussions followed each one of them.

In the afternoon the Section did not meet, on account of the visit to the National Physical Laboratory, which had been arranged for that day in response to the kind invitation of the Director.

The Section again met on Friday morning at 10 A.M. for a discussion of methods of protection, opened by Dr. G. W. C. Kaye, of the National Physical Laboratory. An animated debate followed, to which M. Pilon (Paris) sent a written contribution (read by Mr. Gough), and the following took part: Dr. Ferreux (Paris), Mr. Pullin (London), Dr. Pirie (Montreal), Dr. Shaxby (Cardiff), and Dr. Moore (London). Dr. Kaye, in his reply, directed attention to the need of standardising the scheme of protection, and proposed the following resolution, which was seconded by Mr. Pullin and unanimously agreed to:

"That the Physics Section of the first International

Congress of Radiology wishes to place on record the desirability of adopting a standard scheme of X-ray and radium protection throughout the world."

The morning session was brought to a close with a valuable paper by Prof. F. L. Hopwood, who dealt in detail with the organisation of a hospital radium service. Considerable discussion ensued, in which Dr. Ferreux, of the Radium Institute, Paris, and Dr. Failla, of the Memorial Hospital, New York, took part.

The afternoon session was opened with a paper (read in title only) by Dr. George Clark (U.S.A.), which was followed by an interesting contribution by Dr. Lewis Simons (London), entitled "The Basis of the Selective Chemical Action of X-rays and Light," and the work of the Section was brought to a close by a discussion dealing with modes of producing currents at constant high potential. This discussion was opened by the chairman (Maj. C. E. S. Phillips), who gave a general survey of the subject. Many speakers stated their views, and Prof. Dessauer described his new methods now in use in Germany. Dr. Moore, Mr. Gunstone, and others contributed to the discussion in which all were agreed as to the desirability of adopting constant high-tension apparatus for accurate physical or therapeutic work.

It is clear from the work of the Congress that physics is playing an important part in the progress of medical radiology, and that the scope of its use-

fulness is ever widening. The study of X-ray spectroscopy, for example (to mention only one aspect of it), has already led to the design of wave-length measuring instruments for use in the ordinary routine work of a medical X-ray department, as well as furnishing a knowledge of organic structures unobtainable by other means. A well-organised exhibition of apparatus held in conjunction with the Congress also testified to the many practical applications that have arisen from work in radiation physics, which has been carried out in many parts of the world during recent years, as well as to the ingenuity of those who provide appliances for medical radiologists.

The truly international character of the Congress was very striking. There were representatives from India and Iceland, from Sweden, Russia, Czechoslovakia, France, Belgium, Germany, Italy, U.S.A., Canada, and so forth; and it was a remarkable fact that this great medical meeting had been made possible by the researches of a physicist whose rare distinction it was to have given to the world a discovery of such far-reaching possibilities for the good of mankind. It was generally acknowledged that the Congress had proved a success; it had, in fact, brought together representative men from many parts of the world, whose enthusiasm was tempered only by a desire to advance cautiously in a field of medical work which is admittedly still imperfectly understood.

C. E. S. PHILLIPS.

Industrial Water Supply.

THE subject of industrial water supply and stream pollution was discussed at the joint meeting of the Institution of Chemical Engineers and the American Institute of Chemical Engineers, which was held on July 17, in Leeds. Messrs. F. P. Veitch and L. C. Benedict, of the Bureau of Chemistry (U.S.A.), contributed a valuable paper on the composition and disposal of wool-scouring waste liquors, in which they described current methods of recovering wool-grease and fertilising material from them, as well as recent work done by the Bureau which indicates the superior advantages of extracting with naphtha and subsequent scouring with soap and water. They estimate that the wool-scouring liquors annually produced in the United States contain, in millions of pounds weight, grease 60-70, potash salts 40-48, nitrogenous matter 15, and dirt 60-90, the total value of which is about 5 million dollars. The authors are convinced that wholesale economic recovery of the valuable ingredients is possible.

Mr. W. L. Stevenson, chief engineer to the Department of Health, Commonwealth of Pennsylvania, criticised most legislative efforts to control pollution of streams as being too peremptory and too punitive, and he advocated the policy of scientific and friendly co-operation between municipality and manufacturer; such a policy is successfully pursued by the Sanitary Water Board of Pennsylvania, which, *inter alia*, has re-classified the waters of that State on the principles of conservation and controlled utilisation. The nature of the restrictive and penalising legislation passed by most States was well shown by Mr. E. B. Bessehevre, of New York, whose paper included a summary of the rules upon which the decisions of courts of justice have been based. Mr. H. C. Parker, of Pennsylvania, described recent developments and improvements in the apparatus used for determining hydrogen-ion concentration in industrial effluents and sewage liquors.

Of the papers presented by British workers, that by Dr. T. Lewis Bailey, of the Ministry of Health, on effluents from ammonia plants of coke-oven and

gas-works, was of outstanding importance. Such effluents, it is well known, are the source of much trouble at sewage-disposal works, and Dr. Bailey has for years past been investigating methods of prevention and cure. He described the probable origins of, and the possible ways of eliminating, the harmful ingredients (chiefly ammonium thiocyanate, ammonium thiosulphate, phenol, organic bases and higher tar-acids), but holding that prevention is better than cure, he indicated how relatively clean ammoniacal liquors can be produced by minimising the time of contact between tar and liquor, and by rapidly cooling the crude gas in water-cooled systems, together with rigid exclusion of "adventitious" air. Bad effluents from ammonia plants can be successfully purified in percolating filters, given proper dilution and adequate regulation, although this method is seldom practicable at gas-works owing to lack of the necessary ground space.

Mr. R. D. Littlefield, also of the Ministry of Health, retold the interesting tale of how the Royal Commission on Sewage Disposal solved the problem of purifying the effluents from Scottish distilleries. Here again the percolating filter did what was required, after suitable inoculation.

Water-softening by the base-exchange method was the subject of two contributions. Dr. E. B. Higgins and Mr. J. P. O'Callaghan summarised the advantages which this method has over the older lime-soda process, and described in outline the preparation of "Permutit," both the artificial material (made from sodium silicate and sodium aluminate) and the natural material, which is prepared from greensand or glauconite. In their opinion, natural zeolite is the better owing to its rapidity of action and of regeneration with sodium chloride solution, as well as on account of its superior mechanical and chemical stability. On the other hand, Dr. T. P. Hilditch and Mr. H. J. Wheaton claimed that the water-softener "Doulcil" is practically free from the defects which the previous authors held to be inherent in all such artificial base-exchange materials.

Societies and Academies.

EDINBURGH.

Royal Society, July 6.—G. Leslie Purser: *Calamoichthys calabaricus* Smith. Pt. i. The alimentary and respiratory systems. *Calamoichthys* is the less known of the two genera of the Polypterini. The histology of the alimentary tract is not so complex as the anatomy would lead one to expect, as the intestinal epithelium is practically the same throughout its length; and as a whole the digestive tract is of a simple piscine type. Gills are well developed, but in addition there is, opening into the pharynx by a median ventral glottis, a pair of lungs, the minute structure and the vascular connexions of which show how well the pulmonary respiratory mechanism is developed.—W. W. Taylor: The precipitation of sols by polyvalent ions. With the alkali salts of methanesulphonic acid and naphthalenetrisulphonic acid, which are neutral, there is only one zone of precipitation of ferric hydroxide sol, which commences abruptly at about 0.0002 *N* and extends up to the saturated solution. It is not followed by a zone of no-precipitation. The range investigated was from 7×10^{-8} *N* to nearly 1.5 *N*. They thus fall in line with the neutral chloride and sulphate solutions. The two zones of precipitation, separated by a zone of no-precipitation ("reversal") obtained with sodium phosphate, which contains OH' and no trivalent anion, is ascribed to the OH'. If this be the case, the analogous behaviour of negative sols with ferric and aluminum salts will be due to their hydrolysis. Whether the presence of a polyvalent ion is also necessary is not certain. With the neutral anions, more or less periodic variations in the rate of precipitation were observed; these are not due to errors in procedure. The valency rule does not hold in the case of the above trivalent anions.—E. Neaverson: Ammonites from the Upper Kimmeridge Clay. The Upper Kimmeridge Clay includes a variable series of clays and sands lying between the Gravesia zones of the Lower Kimmeridgian and the base of the Portland Stone Series. The zonal sequence is here tabulated with equivalent stratigraphical terms.

- | | |
|-----------------------|---|
| 5. pallasioides zone | } Hartwell Clay |
| 4. rotundum zone | |
| 3. pectinatus zone | Swindon Sands; Oil Shale of Kimmeridge. |
| 2. nodiferous zone | } Kimmeridge Clay (in part) |
| 1. Wheatleyensis zone | |

The ammonites have hitherto been grouped under the name *Ammonites biplex* which, as Lamplugh pointed out thirty years ago, is useless for stratigraphical purposes. Though the forms found in the Hartwell Clay are familiar (but undescribed), those in the lower two zones are practically unknown in literature, and none has previously been described or figured. Some of these ammonites have been recognised in the Upper Kimmeridge Clay (*sensu anglico*) of Boulogne, but their identity with Russian forms (suggested by Pavlov and others) is not accepted. Indeed, palæogeographical considerations seem to indicate that the British and Russian areas were not in direct communication during the period when these ammonites flourished.—Prof. A. A. Lawson: A contribution to the life-history of *Bowenia*.—J. E. Nichols: Meteorological factors affecting fertility in sheep. The association of climatic conditions at times of service and lambing in a Cheviot and a Blackface flock, kept under the same conditions of pasturage, altitude and management for fourteen years, and data of fertility are examined. Significant evidence of differential responses of the two breeds are presented, and of the meteorological factors considered, the mean tempera-

ture at time of service is shown to exert the greatest influence.

PARIS.

Academy of Sciences, July 15.—G. Bigourdan: The mean errors of the various modes of observation of the time signals. Over their longest paths, the perturbations of Hertzian waves have no influence on the time of transmission exceeding 0.01 sec. The error due to the mode of reception of the waves is of the same order of magnitude.—René Lagrange: The uniform deformation of a beam and the equation $\frac{\partial^4 F}{\partial x^4} + 2 \frac{\partial^4 F}{\partial x^2 \partial y^2} + \frac{\partial^4 F}{\partial y^4} = 0$.—Eydoux: The graphical determination of the meridian lines of turbine blades.—P. Choux: The Cupanæ of Madagascar.—A. Tronchet: Vascular acceleration in schizocotyly.—Alexandre Lipschutz: Unilateral phenomena resulting from castration.—Henri Pottevin and Robert Faillie: Work during walking.

CAPE TOWN.

Royal Society of South Africa, June 17.—A. W. Roberts: A statistical inquiry into the population problem in South Africa. The rate of increase of the white population in the Cape Colony is subject to a cyclical variation completed in 170 years. The rate of increase has been decreasing during the past twenty years. In Natal, exact statistics go back to 1860, and again there is evidence of cyclical variation. The rate of increase has been steadily decreasing during the past ten or fifteen years. This condition is also found in the Orange Free State and the Transvaal. Early enumerations of the native population are not available. Those taken in recent years indicate a declining rate in every instance but one, Zululand. The rate is increasing here, but very slowly.—W. J. Copenhagen: A note on Azotobacter in some South African soils. Soils from a number of localities in the Cape Province were examined and records made of the hydrogen-ion concentration, moisture, amount of organic matter, nitrogen per gram, characters of cultures, and nitrogen fixed per culture.—J. Moir: Colour and chemical constitution, Pt. xx.: Some residual problems.

ROME.

Royal Academy of the Lincei, June 5.—P. Burgatti: Conditions of validity of Lagrange's equations.—U. Cisotti: Fundamental equations of potential laminary motions on any surface.—G. Armellini: A theorem on the problem of two bodies of increasing masses.—N. Parravano and G. Malquori: Reactivity of silver with oxygen.—C. F. Parona: New observations on the chalks with *Heterodicerus Luci* of the Parenzo coast in Istria.—Gaetano Rovereto: New observations on the crystalline mass of Savona.—E. Carano: Detailed development of the female gametophyte of *Euphorbia dulcis* L.—Fil. Bottazzi and L. De Caro: Further results on the variations in the electrical resistance of muscles caused by solutions having different P_n values.—A. L. Herrera: Imitation of the smallest details of the Microsporidia by means of calcium fluosilicate.—Gianna Calzolari: Totality of analytical functions.—Minea Chini: Determination of the geodetics of certain surfaces.—Gaetano Scorza: Complex algebraics connected with groups of infinite order.—Vasco Ronchi: A new stellar interferometer.—A. Ferrari: Crystalline lattices and isomorphism of lithium and magnesium fluorides. The structure of magnesium fluoride is of the rutile type, and the volumes of the elementary cells, containing four

molecules in the case of lithium fluoride and two in that of magnesium fluoride, are practically equal.—G. Cannieri and L. Fernandes: Contribution to the study of certain minerals containing thallium: thermal analysis of the systems, $Tl_2S-As_2S_3$ and Tl_2S-PbS .—G. Scagliarini: Complexes of quinquevalent molybdenum.—Ardito Desio: The geological constitution of some of the smaller islands of the Dodecanese.—C. Jucci: Races of silkworms with three or four mutations: Study of crosses.

Official Publications Received.

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 12, Part 3: Some Studies on a Japanese Apple Canker and its Causal Fungus, *Valsa Mah.* By Kogo Togashi. Pp. 266-324+plates 27-30. Vol. 15, Part 4: On the *Platygodidae* of Formosa; Supplementary Notes on "The *Platygodidae* of Formosa," by Jozo Muayama; Notes on the Japanese *Mantispidae*, with Special Reference to the Morphological Characters. By Satoru Kuwayama. Pp. 197-267+plates 12-16. (Sapporo)

Proceedings of the Cambridge Philosophical Society. Vol. 22, Part 5, July. Pp. 601-812. (Cambridge: At the University Press.) 10s. net.

Union of South Africa: Department of Agriculture. Science Bulletin No. 39: Streak Disease of Sugar-Cane. By H. H. Storey. Pp. 10. (Pretoria: Government Printing and Stationery Office.) 3d.

Meddelanden fran Statens Skogsofversoksanstalt. Hefte 22, No. 1: Grundvattenrorelser och Forsumpningsprocesser belysta genom Bestamningar av Grundvattnets syrehalt i Nordsvenska Moraner: Grundvasserbewegungen und Versumpfungsprozesse, durch Sauerstoffanalysen des Grundwassers nordschwedischer Moranen erlautert. Av Olof Tamm. Pp. 44. Hefte 22, No. 2: Vattidsundersokningar a tall och gran: Recherches sur la marche de l'accroissement chez le pin et l'epicea durant la periode de vegetation. Av Jarr-Gunnar Romell. Pp. 45-124. (Stockholm.)

The Journal of the Institute of Metals. Vol. 33. Edited by G. Shaw Scott. Pp. xii+710+15 plates. (London: 36 Victoria Street.) 31s. 6d. net.

Eugenics in Relation to the New Family and the Law on Racial Integrity: including a Paper read before the American Public Health Association. Second edition. Pp. 32. (Richmond, Va.: Bureau of Vital Statistics, State Board of Health.)

University of California Publications in American Archaeology and Ethnology. Vol. 22, No. 1: Wyot Grammar and Texts. By Gladys A. Reichard. Pp. 215. (Berkeley, Cal.) 2 7/8 dollars.

Aeronautical Research Committee. Reports and Memoranda, No. 963 (Ae 179): Notes on Stalled Flying. By Squadron Leader R. M. Hill and H. L. Stevens. (A.2.b. Stability-Full Scale Experiments, 22—T. 1757.) Pp. 9+1 plate. 6d. net. Reports and Memoranda, No. 964 (Ae. 180): The Control of a Stalled Aeroplane as affected by the Use of Differential Ailerons. By H. L. Stevens. (A.2.a. Stability Calculations and Model Experiments, 58—T. 1986.) Pp. 5+2 plates. 6d. net. Reports and Memoranda, No. 965 (Ae. 181): Pitching and Yawing Moments with Sideslip on a Model Aeroplane with Zero Stagger. By F. B. Bradfield. (A.2.a. Stability Calculations and Model Experiments, 91—T. 2021.) Pp. 14+5 plates. 1s. net. Reports and Memoranda, No. 970: Report of the Airworthiness of Airships Panel. (D.1. Special Technical Questions, 115—T. 1944.) Pp. 19. 9d. net. (London: H.M. Stationery Office.)

The National Physical Laboratory. Watch and Chronometer Trials, 1923-24. Pp. 7. (London: H.M. Stationery Office.) 6d. net.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Montserrat, 1922-23 and 1923-24. Pp. iv+50. (Barbados.) 6d.

Otago University Museum and Hocken Library. Annual Reports for the Year 1924. Pp. 16. (Dunedin, New Zealand.)

Society of Chemical Industry. Chemical Engineering Group. Proceedings, Vols. 5 and 6a, 1923-1924. Pp. x+130. (London: Abbey House, Victoria Street.) 10s. 6d.

Empire Cotton Growing Corporation. Report on the Cotton-Growing Industry in Uganda, Kenya and the Mwanza District of Tanganyika; with Map of the Eastern Province of Uganda. By Col. C. N. French. Appendices 1 and 2 by W. C. Jackson. Pp. 44. (London: Empire Cotton Growing Corporation.) 1s. 3d.

The Indian Forest Records. (Silviculture Series), Vol. 11, Part 7: Volume Tables for *Tectona grandis* (Teak) and *Shorea robusta* (Sal) for the Central Provinces. By V. K. Maitland. Pp. 8+4 plates. 9 annas; 11d. (Entomology Series), Vol. 11, Part 8: The Economic Importance and Control of the *Sal* Heartwood Borer (*Hoplocerambyx siccicornis* Newm., fam. *Cerambycidae*). By G. F. O. Beeson and N. C. Chatterjee. Pp. iv+47+8 plates. 1.4 rupees; 2s. 3d. (Calcutta: Government of India Central Publication Branch.)

Forest Bulletin No. 59 (Economy Series): Summary of Results of Treated and Untreated Experimental Sleepers laid in the various Railway Systems of India, brought up to date. By J. H. Warr. Pp. 84+4 plates. 1.14 rupees; 3s. 3d. Forest Bulletin No. 61 (Botany Series): Eucalyptus in the Plains of North West India. By R. N. Parker. Pp. 34. 5 annas; 6d. (Calcutta: Government of India Central Publication Branch.)

Empire Cotton Growing Corporation. Reports received from Experiment Stations for the Seasons 1923, 1924 and 1925 (South Africa only). Pp. 48+9 plates. (London: Empire Cotton Growing Corporation.)

Department of the Interior. Bureau of Education. Bulletin, 1924, No. 39. Visual Education and the St. Louis School Museum. By Carl G. Rathman. Pp. iv+36. Bulletin, 1925, No. 2. Important State Laws relating to Education enacted in 1922 and 1923. Compiled by William R. Hood. Pp. iv+82. (Washington: Government Printing Office.) 10 cents each.

State of Connecticut. Public Document No. 24: Forty-seventh Annual Report of Connecticut Agricultural Experiment Station; being the Annual Report for the Year ended October 31, 1923. Pp. viii+534+xlvi+26 plates. (New Haven, Conn.)

Department of Commerce. Bureau of Standards. Technologic Paper of the Bureau of Standards, No. 284: A Study of the Seasonal Variation of Radio-frequency Phase Difference of Laminated Phenolic Insulating Materials. By J. L. Preston and E. L. Hall. Pp. 223-234. (Washington Government Printing Office.) 5 cents.

Agricultural Experiment Station: Michigan Agricultural College. Special Bulletin No. 143: Winter Pruning the Black Raspberry. B. Stanley Johnston. Pp. 22. Special Bulletin No. 145: Christmas Tree Plantations. By A. K. Chittenden. Pp. 9. Special Bulletin No. 146: Air-Cooled Storage for Apples. By Roy E. Marshall. Pp. 54. Special Bulletin No. 147: Cherry Leaf-Spot; Residual Effects and Control. B. W. C. Dutton and H. M. Wells. Pp. 15. (East Lansing, Mich.)

Annual Report of the Board of Regents of the Smithsonian Institution showing the Operations, Expenditures and Condition of the Institution for the Year ending June 30, 1923. (Publication 2758.) Pp. xi+578+10 plates. (Washington: Government Printing Office.) 2 dollars.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. Edited by W. F. Spear. New Series, No. 23, April. Pp. 203. (London: The Institution of Civil Engineers.)

Smithsonian Miscellaneous Collections. Vol. 77, No. 5: Solar Variation and Forecasting. By O. G. Abbot. (Publication 2825.) Pp. 27. Vol. 77, No. 6: Solar Radiation and Weather, or Forecasting Weather from Observations of the Sun. By H. H. Clayton. (Publication 2826.) Pp. 64. Vol. 77, No. 7: Solar Radiation and the Weekly Weather Forecast of the Argentine Meteorological Service. By Guillermo Hoxmark. (Publication 2827.) Pp. 23. (Washington: Smithsonian Institution.)

Ministry of Public Works, Egypt: Zoological Service. Publication No. 38: Report on the Zoological Service for the Year 1923, in which is included the 25th Annual Report of the Giza Zoological Gardens. B. Major S. S. Flower. Pp. iii+20. (Cairo: Government Publication Office.) 5 P.T.

Diary of Societies.

SATURDAY, AUGUST 29.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 3.—Dr. F. A. Dixey: Mimicry in relation to Geographical Distribution (Lecture for Young People).—At 8.—Prof. E. V. Appleton: The Role of the Atmosphere in Wireless Telegraphy (Citizens' Lecture)

MONDAY, AUGUST 31.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 10 A.M.—Prof. C. H. Desch: The Chemistry of Solids (Presidential Address to Section B).—Prof. A. V. Hill: The Physiological Basis of Athletic Records (Presidential Address to Section I).—Dr. J. B. Orr: The Inorganic Elements in Animal Nutrition (Presidential Address to Section M).—At 3.—W. H. Barker: The Development of Southampton in relation to World Commerce (Lecture for Young People).—At (Section K).—Dr. D. H. Scott: Some Points in the Geological History of Plants (Lecture).—At 8.—Capt. P. P. Eekersley: Some Technical Problems of Broadcasting (Citizens' Lecture).

TUESDAY, SEPTEMBER 1.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton), at 3.—Prof. W. J. Dakin: Whaling in the Southern Ocean (Lecture for Young People).—At 8.—C. J. P. Cave: The Highway of the Air (Citizens' Lecture)

INSTITUTE OF METALS (Autumn Meeting, Glasgow), at 8 P.M.—Sir John Dewrance: Education, Research, and Standardisation (Lecture)

WEDNESDAY, SEPTEMBER 2.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Southampton)

INSTITUTE OF METALS (Autumn Meeting, Glasgow), at 10 A.M.—A selection from the following papers:—R. J. Anderson and E. G. Fahiman: The Effect of Low-Temperature Heating on the Release of Internal Stress in Brass Tubes.—Prof. J. H. Andrew and R. Hay: Colloidal Separation in Alloys.—J. S. Brown: The Influence of the Time Factor on Tensile Tests conducted at Elevated Temperatures.—L. H. Callendar: Passivation and Scale Resistance in relation to the Corrosion of Aluminium Alloys.—R. B. Deeley: Zinc-Cadmium Alloys.—A Note on their Shear Strengths as Solders.—J. W. Donaldson: Thermal Conductivities of Industrial Non-Ferrous Alloys.—Prof. O. W. Ellis: The Influence of Pouring Temperature and Mould Temperature on the Properties of Lead-Base Anti-Friction Alloy.—Dr. Marie L. V. Gayler: On the Constitution of Zinc-Copper Alloys containing 45 to 65 per cent. of Copper.—Dr. R. H. Greaves and J. A. Jones: The Effect of Temperature on the Behaviour of Metals and Alloys in the Notched-Bar Impact Test.—Dr. D. Hanson and Dr. Marie L. V. Gayler: On the Constitution of Alloys of Aluminium, Copper, and Zinc.—Dr. J. L. Haughton and W. T. Griffiths: The β Transformations in Copper-Zinc Alloys.—Dr. H. Hyman: The Properties of some Aluminium Alloys.—D. H. Ingall: The High Temperature-Tensile Curve. (a) Effect of Rate of Heating (b) Tensile Curves of some Brasses.—C. H. M. Jenkins: The Physical Properties of the Copper-Cadmium Alloys Rich in Cadmium.—G. F. Phillips: The Primitive Copper Industry of America.—D. Stockdale: The Alpha-Phase Boundary in the Copper-Tin System.

THURSDAY, SEPTEMBER 3.

INSTITUTE OF METALS (Autumn Meeting, Glasgow), at 10 A.M.—A selection from the papers given above.

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The Figure and Constitution of the Earth.¹

By Prof. HORACE LAMB, Sc.D., LL.D., F.R.S., President of the British Association.

WHEN one is confronted, as on this occasion, with the British Association in plenary session, it is permissible, I hope, to indulge in a few reflections on the nature and purpose of science in general. The theme is no new one and has never been discussed so frequently as in our time, but the very range of our activities entitles us to consider it from our own point of view. The subjects treated at these meetings range, according to the titles of our Sections, from the most abstract points of mathematical philosophy to the processes of agriculture. Between these limits we have the newest speculations of astronomy and physics, the whole field of the biological sciences, the problems of engineering, not to speak of other matters equally diverse. These subjects, again, have become so subdivided and specialised that workers in adjacent fields have often a difficulty in appreciating each other's ideas, or even understanding each other's language. What then is the real purpose of science in the comprehensive sense; what is the common inspiration, the common ambition, behind such enthusiastic and sustained effort in so many directions?

The question may seem idle, for a sort of official answer has often been given. It was deemed sufficient to point to the material gains, the enlarged powers, which have come to us through science, and have so transformed the external part of our lives. The general aim was summed up in an almost consecrated formula: "to subdue the forces of Nature to the service of man"; and since it was impossible to foresee what abstract research might or might not provide a clue to something useful, the more speculative branches of science were not only to be tolerated, but also to be encouraged within limits, as ancillary to the supreme end. And, it must be said, the cultivators of these more abstruse sciences have themselves been willing sometimes to accept this position. The apologists of pure mathematics, for example, have been wont to appeal to the case of the conic sections, which from the time of Apollonius onwards had been an entirely detached study, but was destined after some 2000 years to guide Kepler and Newton in formulating the laws of the

planetary motions, and so ultimately to find its justification in the Nautical Almanac.

I will not stop to examine this illustration, which I personally think rather strained. We may recognise that practical utility has been a conscious though not the sole aim in much scientific work, and sometimes perhaps its main justification; but we can scarcely admit that any such formula as I have quoted worthily conveys what has been the real inspiration of discovery through the ages. If we may go back to Apollonius and the conic sections, we cannot suppose that he was thinking of posterity at all; he was engaged in a study which he no doubt held to be legitimate and respectable in itself. Or, to take a very recent instance, when Faraday and Maxwell were feeling their way towards an electric theory of light, they could scarcely have dreamed of wireless telegraphy, though, as we now know, this was no remote development. The primary aim of science as we understand it is to explore the facts of Nature, to ascertain their mutual relations, and to arrange them so far as possible into a consistent and intelligible scheme. It is this endeavour which is the true inspiration of scientific work, as success in it is the appropriate reward. The material effects come later, if at all, and often by a very indirect path.

We may, I think, claim for this constructive task something of an æsthetic character. The provinces of art and science are often held to be alien and even antagonistic, but in the higher processes of scientific thought it is often possible to trace an affinity. The mathematician, at all events, is at no loss for illustrations of this artistic faculty. A well-ordered piece of algebraical analysis has sometimes been compared to a musical composition. This may seem fantastic to those whose only impression is that of a mass of curious symbols; but these bear no more resemblance to the ideas which lie behind them than the equally weird notation of a symphony bears to the sounds which it connotes or the emotions which these evoke. It is no misplaced analogy which has led enthusiasts to speak of the poetical charm of Lagrange's work, of the massive architecture of Gauss's memoirs, of the classic perfection of Maxwell's expositions. The devotees of other

¹ Inaugural address delivered to the British Association at Southampton on August 26.

sciences will be at no loss for similar illustrations. Is it not the case, for example, that the widespread interest excited by the latest achievements of physical science is due not to the hope of future profit, though this will doubtless come, but to the intrinsic beauty as well as the novelty of the visions which they unfold?

It is possible, I trust, to insist on these aspects of the scientific temperament without wishing to draw a sharp and even mischievous antithesis between pure and applied science. Not to speak of the enormous importance in our present civilisation of the material advantages which have come in the train of discovery, it would be disloyal to science itself to affect to depreciate them. For the most severely utilitarian result comes often as the result of a long and patient process of study and experiment, conducted on strictly scientific methods. We must recognise also the debts which pure science in its turn owes to industry, the impulse derived from the suggestion of new problems, and not least the extended scale on which experiment becomes possible. Reference may appropriately be made here to the National Physical Laboratory, initiated mainly in the higher interests of industry, which by the mere pressure of the matters submitted to it is becoming a great institute of theoretical as well as applied science, informed throughout by the true spirit of research.

But perhaps the most momentous consequences of the increased scientific activities of our time have been on the intellectual side. How profound these have been in one direction we have recently been reminded by the centenary of Huxley. Authority and science were at one time in conflict over matters entirely within the province of the latter. The weapons were keen and the strife bitter. We may rejoice that these antagonisms are now almost obsolete; one side has become more tolerant, the other less aggressive, and there is a disposition on both sides to respect each other's territories. The change is even reflected in the sermons delivered before the British Association. The quarters where we may look for suspicion and dislike are now different; they are political rather than ecclesiastical. The habit of sober and accurate analysis which scientific pursuits tend to promote is not always favourable to social and economic theories, which rest mainly on an emotional if very natural basis. Some of us, for example, may remember Huxley's merciless dissection of the theory of the social contract. There is hence to be traced, I think, a certain dumb hostility which, without venturing on open attack, looks coldly on scientific work except so far as it is directed to purposes of obvious and immediate practical utility.

There is a more open kind of criticism to which we are exposed, which we cannot altogether ignore, though it again rests on a misconception of the true function of

science. It is to be met with in quarters where we might fairly look for countenance and sympathy, and is expressed sometimes with great force, and even eloquence. The burden is one of disappointment and disillusion; we even hear of the "bankruptcy of science." It seems to be suggested that science has at one time or other held out promises which it has been impotent to fulfil; that vague but alluring hopes which it has inspired have proved delusive. It may be admitted that extravagant and impossible claims have sometimes been made on behalf of science, but never, I think, by the real leaders, who have always been most modest in their claims and guarded in their forecasts. It is true, again, that in the enthusiasm which attended the first sensational developments of modern industry, hopes were conceived of a new era where prosperity would ever increase, poverty would be at least mitigated and refined, national antipathies would be reconciled. When these dreams did not swiftly come true there was the inevitable reaction; the idols were cast down, and science in general has rather unreasonably come in for its share of depreciation. The attitude which I have been trying to describe is put very forcibly in a quotation from President Wilson which I saw not long ago, though its date is not very recent:

"Science has bred in us a spirit of experiment and a contempt for the past. It made us credulous of quick improvement, hopeful of discovering panaceas, confident of success in every new thing. . . . I should fear nothing better than utter destruction from a revolution conceived and led in the scientific spirit. Science has not changed the laws of social growth or betterment. Science has not changed the nature of society, has not made history a whit easier to understand, human nature a whit easier to reform. It has won for us a great liberty in the physical world, a liberty from superstitious fear and from disease, a freedom to use nature as a familiar servant; but it has not freed us from ourselves."

The tone is one of bitter disillusion, but we may ask why should science, as we understand it, be held responsible for the failure of hopes which it can never have authorised? Its province, as I have tried to define it, is vast, but has its limits. It can have no pretensions to improve human nature; it may alter the environment, multiply the resources, widen the intellectual prospect, but it cannot fairly be asked to bear the responsibility for the use which is made of these gifts. That must be determined by other and, let us admit it, higher considerations. Medical science, for example, has given us longer and healthier lives; it is not responsible for the use which we make of those lives. It may give increased vitality to the wicked as

well as the just, but we would not, on that account, close our hospitals or condemn our doctors.

In spite of the criticisms I have referred to, we may still hold up our heads, let us hope without arrogance, but with the confidence that our efforts have their place, not a mean one, in human activities, and that they tend, if often in unimagined ways, to increase the intellectual and the material and even the æsthetic possessions of the world. In that assurance, we may rejoice that science has never been so widely and so enthusiastically cultivated as at the present time, with so complete sincerity, or (we may claim) with more brilliant success, or even with less of international jealousy.

Passing from these reflections, which are, I hope, not altogether inopportune, it is expected that the president of the British Association should deal with some subject in which he has himself been interested. For a mathematician this obligation is a specially difficult one, if he is not to overstrain the patience of his audience. I propose to speak briefly, and mainly from the mathematical and physical point of view, about some branches of geophysics, and in particular those relating to the constitution of the earth. It is a subject which in the past has often engaged the attention of the Association. I need only recall the names of Kelvin and George Darwin, and the controversies with which they are associated. Historically, it is of special interest to the mathematician and the physicist, for it was in his researches on the figure of the earth that Laplace initiated the theory of its potential, with its characteristic equation, and so prepared the way for Poisson, Green, Cauchy, and a host of followers, who developed the theory of electricity and ultimately that of light. To go further back, it was in this connexion that Newton found an important verification of his law of gravity. Quite recently, the whole subject has been reviewed in a valuable treatise by Dr. Jeffreys, who arrives at conclusions which are at all events definite, and maintained with great ability.

I do not propose to deal with the fascinating speculations as to the past history of the earth and its reputed child, the moon, which will be more or less familiar. I must confine myself to a rapid survey of the information as to its present constitution, which can be gathered from observations made in our own time, and capable of repetition at will. This, though less exciting, is at all events a region in which imagination is more subject to control.

The accurate investigation of the figure of the earth is intimately connected with the variation of gravity over its surface. In view of the local irregularities, some convention was necessary as to what is meant by the shape of the earth as a whole. The usual

definition is that it is a level surface as regards the resultant of true gravity and centrifugal force: often that particular level surface of which the sea forms a part. I need not dwell on the immense amount of theoretical and practical labour which has been devoted in various countries to the determination of the geometrical surface which most nearly satisfies this requirement. Of more recent interest are the irregularities in the intensity of gravity, which have been found to exist over wide areas, by the highly trained Survey of India, by the Coast and Geodetic Survey of the United States, and by various observers on the continent of Europe. Briefly, the general result is this, that in mountainous regions the observed value of gravity is abnormally low, whilst on oceanic islands, and so far as can be ascertained on the sea, it is abnormally large, when all allowance has been made for altitude and the normal variation with latitude. The fact that this has been found to be the case in so many different places, shows that we have here to deal with no casual phenomenon.

The accepted explanation, originated by Archdeacon Pratt, of Calcutta, in 1859, and since developed by Hayford and Bowie, of the U.S. Survey, is that if we imagine a level surface to be drawn at a depth of about 100 kilometres, the stratum of matter above this, though varying in density from point to point, is approximately uniform, in the sense that equal areas of the surface in question bear equal weights. The altitude of the mountains is held to be compensated by the inferior density of the underlying matter, whilst the oceanic hollows are made up for by increased density beneath. Leaving aside the technical evidence on which this hypothesis is based, there are one or two points to be noticed. In the first place it suggests, as is highly plausible on other grounds, that the matter in the interior of the earth, below the stratum referred to, is in a state of purely hydrostatic stress, *i.e.* of pressure uniform in all directions. So far as this stratum is concerned, it might be floating on an internal globe of liquid, although no assertion is really made, or is necessary, to this effect. But in the stratum itself, shearing forces must be present, and it is necessary to consider whether the actual material is strong enough to withstand the weight of continents and mountains, and the lack of lateral support due to the oceanic depressions. The researches of Prof. Love and others show that this question can fairly be answered in the affirmative.

The accurate determination of the acceleration of gravity at any place is, of course, a matter of great delicacy. Not to mention other points, in the pendulum method the yielding of the support due to the reaction of the pendulum as it swings to and fro affects

the time of oscillation. It may be recalled that, so far back as 1818, Kater, in his absolute determination of the length of the seconds pendulum in London, was on his guard against this effect, and devised a test to make sure that it was in his case negligible. In a portable apparatus, such as is used for comparative determinations, it is difficult to give sufficient rigidity to the support, and a correction has, in some way, to be applied. Recently, Dr. F. A. V. Meinesz, of the Dutch Survey, who has carried out an extensive gravity survey in Holland, has sought to minimise this effect by the use of pairs of pendulums swinging in opposite phases, and so reacting on the support in opposite senses. This has opened out a prospect of accurate gravity determinations at sea. The use of a pendulum method on a surface vessel is scarcely possible, but a submarine when sufficiently immersed offers comparative tranquillity, and it is hoped that the small residual horizontal motions may be capable of elimination, and the diminished vertical oscillation allowed for. The methods previously employed at sea which could claim any accuracy are those of Hecker. In one method, the pressure of the atmosphere is found in absolute measure from the boiling point of water and compared with the gravitational measure afforded by the barometer. In a more recent method, also devised by Hecker, and followed with some modifications by Duffield, the idea is to carry about a standard atmosphere, *i.e.* a mass of air at constant volume and prescribed temperature, the pressure of which is measured gravitationally by the barometer. Both methods are highly ingenious, but cannot compete as regards accuracy with the pendulum method if this should be found practicable.

It is a matter of regret that the observational side of geophysics has of late been so little cultivated in Great Britain. In India, with its wide opportunities, geodetic and gravitational work has long been carried on with high efficiency, and has furnished essential material for the generalisations I have referred to. But in the Home country, although we have an admirable topographical survey, nothing so far as I know has been done towards a gravity survey since the time of Kater, more than a century ago. Proposals for the establishment of a formal Geodetic Institute, such as existed in some other countries before the War, which should embrace this as well as other subjects, have been urged, but have had to be abandoned owing to the exigencies of the time. It is therefore some satisfaction to record that a modest beginning has been made at Cambridge by the institution of a readership in geodesy, and that, when the requisite pendulum outfit is complete, it is hoped that a gravity survey of the British Isles may be initiated. The physical features are scarcely so rugged that sensational results such as were found in India are to be expected; but it is desirable that the work, which will involve comparatively little labour and expense after the initial steps, should be carried out. The example of Holland shows that in a country which has no outstanding features at all, a survey may reveal peculiarities which are at all events of considerable interest. I may add that it is contemplated that the Cambridge apparatus should also be designed to eliminate the disturbing element I have mentioned,

and that it should be available for determinations at sea. It is perhaps not too much to hope that, with the co-operation of the Navy, the gravity chart of the world, which is so far almost a blank as regards the ocean, may in this way be gradually filled in.

The distribution of the intensity of gravity over the surface of the earth gives by itself no positive information as to the distribution of density throughout the interior, though the contrary view has sometimes been held. For example, a spherical globe with a uniform intensity of gravitation over its surface would not necessarily be homogeneous, or even composed of spherical strata each of uniform density, however plausible this might be on other grounds. Consequently, there is room for hypothesis. There are certain tests which any hypothesis has to satisfy. It must account for the observed distribution of gravity, and having regard to the phenomena of precession, it must give the proper relation between the earth's moments of inertia about a polar and an equatorial axis. It may be added that it should be fairly consistent with the ascertained velocities of seismic waves at different depths, and the degree of elasticity which it is allowable to assign to the material. The somewhat artificial laws of density adopted by Laplace and Roche, respectively, mainly on grounds of mathematical convenience, have lost much of their credit. A more natural law, suggested indeed by Thomson and Tait in 1867 in their book on natural philosophy, has since been proposed in a more definite form by Wiechert. On this view, the earth is made up of a central core of about four-fifths the external radius, of high density, about that of iron, surrounded by an envelope of about the density of the surface rocks. This is, of course, only to be taken as a rough picture, but it satisfies the requirements I have mentioned, and is apparently not incompatible with the seismic data.

In all speculations on the present subject, considerations as to the thermal history of the earth and the present distribution of temperature in the interior play an essential part. The apparent inconsistency between the requirements of physics and geology was long a matter of controversy, and has given rise to keen debate at British Association meetings. Lord Kelvin's historic attempts to limit the age of the earth, by consideration of the observed temperature gradient as we go downwards from the surface, lost their basis when it was discovered that the rate of generation of heat in the processes of radioactive change was amply sufficient to account for the present gradient, and would even be far more than sufficient unless the amount of radioactive material concerned were strictly limited. Assuming an average distribution of such material similar to what is found near the surface, a stratum of some 16 kilometres in thickness would provide all that is wanted. Radioactive speculation has gone further. A comparison of the amounts of uranium, and of the end-products associated with it, has led to estimates of the time that has elapsed since the final consolidation of the earth's crust. The conclusion is, that it must lie definitely between 10^9 and 10^{10} years. The figure is necessarily vague owing to the rough value of some of the data, but even the lower of these limits is one which geologists and biologists are, I believe, willing to accept, as

giving ample scope for the drama of evolution. We may say that physics has at length amply atoned for the grudging allowance of time which it was once disposed to accord for the processes of geological and biological change.

The radioactive arguments on which these estimates are based are apparently irrefutable; but from the physical point of view there are reasons why one would welcome an extension even of the upper limit of 10^{10} years if this could possibly be stretched. For if this barrier be immovable, we are led to conclusions as to the present internal temperature of the earth which are not quite easy to reconcile with the evidence as to rigidity to be referred to in a moment. In the space of time I have mentioned, enormous as it is, the great mass of the earth could scarcely have cooled very much from the temperature when it was in a state of fusion. The central portion, whatever its nature, and however high its thermal conductivity, is enclosed by a thick envelope of feebly conducting material, just as a steam boiler, for example, may be jacketed with a layer of asbestos. To take a calculable hypothesis, we may assume with Wiechert that we have a central core of three-fourths the earth's radius, with an outer shell of rock. We may give the core any degree of conductivity we like; for mathematical simplicity we may even regard it as infinite. Then, if the outer layer consists of material having some such conductivity as the surface rocks, the internal temperature would take to fall to one-half its original value a period of at least ten times the limit I have named. It is obvious that the details of the assumption may be greatly varied without affecting the general conclusion of a very high internal temperature.

The question as to the degree of rigidity of the earth has so often been dealt with that a brief recapitulation must suffice. It was about the year 1862 that Kelvin first pointed out that if the earth as a whole were only as rigid as a globe of glass or even steel, it would yield so much to the deforming action of the solar and lunar tidal forces as seriously to affect the amplitudes of the oceanic tides, which are a differential effect. Unfortunately, the tides are so much complicated by the irregular distribution of land and sea that a comparison with the actual values of the theoretical amounts which they would have on the hypothesis of absolute rigidity is hopeless. The fortnightly tidal component, due to the changing declination of the moon, is probably an exception, but the difficulty here is to extract this relatively minute component from the observations, and the material is consequently imperfect. The problem was attacked in a different way by G. and H. Darwin in 1881. The horizontal component of the lunar and solar disturbing forces must deflect the apparent vertical, and it was sought to measure this effect by a pendulum. The quantities to be determined are so excessively minute, and the other disturbing forces so difficult to eliminate, that the method was only carried out successfully by Hecker in 1907, and afterwards by Orloff in Russia. The results on the whole were to the effect that the observed deflexions were about three-fifths of what they ought to be if the earth were perfectly unyielding, and were, so far, in accordance with estimates previously made by Darwin and others, from the somewhat imperfect statistics of the fortnightly tide.

There was, however, a discrepancy between the results

deduced from the deflexions in the meridian and at right angles to it, which gave rise to much perplexity. The question was finally set at rest by Michelson in 1916. He conceived the idea of measuring the tides produced in two canals (really two pipes half filled with water) of about 500 feet long, extending one N. and S., the other E. and W. These tides are, of course, of a microscopic character, their range is of the order of one-hundredth of a millimetre, and they could only be detected by the refined optical methods which Michelson himself has devised. The observations, when plotted on a magnified scale, exhibit all the usual features of a tide-gauge record: the alternation of spring and neap tides, the diurnal and semi-diurnal lunar tides, and so on. The theoretical tides in the canals can, of course, be calculated with great ease, and the comparison led to the result that the ratio which the observed tides bore to the theoretical was about 0.69, being practically the same in both cases. The whole enterprise was as remarkable for the courage of its inception as for the skill with which it was carried out, and was worthy of the genius which has accomplished so many marvels of celestial and terrestrial measurement. The perplexing discrepancy in the results obtained by Hecker at Potsdam is no doubt to be explained by the attraction of the tidal waters in the not very remote North Sea, and by the deformation due to the alternating load which they impose on the bottom. In Chicago, near the centre of the American continent, these influences were absent.

The question may be asked: What is the precise degree of rigidity which is indicated by these observations, or by others which have been referred to? Various answers have been given, based on observations of the tides, of the lunar deflexion of the vertical, and of the period of the earth's Eulerian nutation, on which I have not touched. The estimates have varied greatly, but they are all high, some of them extremely high. That they should differ among themselves is not surprising. The material is certainly not uniform, either in its elastic properties or the conditions to which it is subject, so that we can only speak of the rigidity of the earth as a whole in some conventional sense. Larmor and Love have shown that all the information that can be gathered, whether from the tides or from the Eulerian nutation, can be condensed into two numerical constants. This leaves a large degree of indeterminateness as to the actual distribution of elasticity within the earth. It is at all events certain that in regard to tidal forces the great bulk of the material must be highly rigid.

In leaving this topic, it may be recalled that it was in this same connexion that Kelvin was led to initiate the method of harmonic analysis as applied to the tides, as well as to accomplish much brilliant mathematical work, the importance of which is by no means limited to the present subject. The whole theory of the tides and cognate cosmical questions afterwards became the special province of George Darwin; but after his death, work on the tides was almost at a standstill until it was resumed by Prof. Proudman and his associate, Dr. Doodson, in the recently established Tidal Institute at Liverpool. They have already arrived at results of great theoretical as well as practical interest.

Within the last twenty years or so, light has come on the elastic properties of the earth from a new and unexpected quarter, namely, from a study of the propagation of earthquake shocks. It is pleasant to recall that this has been largely due to efforts especially fostered, so far as its means allowed, by the British Association. To John Milne, more than to any one else, is due the inception of a system of widely scattered seismological stations. The instruments which he devised have been improved upon by others, notably by Galitzin, but it is mainly to his initiative that we are indebted for such insight as has been gained into the elastic character of the materials of the earth, down, at least, to a depth of half the radius. It may be remarked that the theory of elastic waves, which is here involved, was initiated and developed in quite a different connexion, in the persistent but vain attempts to construct a mechanical representation of the luminiferous ether which exercised the mathematical physicists of a generation or two ago. It has here at length found its natural application.

One of the first problems of seismologists has been to construct, from observation, tables which should give the time which an elastic wave of either of the two cardinal types, namely, of longitudinal and transverse vibration, takes to travel from any one point of the earth's surface to any other. It has been shown by Herglotz and Bateman that if these data were accurately known it should be possible, though naturally by a very indirect process, to deduce the velocities of propagation of the two types throughout the interior. Such tables have been propounded, and are in current use for the purpose of fixing the locality of a distant earthquake when this is not otherwise known. They are, however, admittedly imperfect, owing to the difficulty of allowing for the depth of the focus, which is not always near the surface, and is sometimes deep-seated. This uncertainty affects, of course, the observational material on which the tables are based. Some partial corrections have been made by Prof. Turner, who almost alone in Great Britain, amidst many distractions, keeps the study of seismology alive, but the construction of accurate tables remains the most urgent problem in the subject.

Taking the material, such as it is, however, the late Prof. Knott, a few years ago, undertook the laborious task of carrying out the inverse process of deducing the internal velocities of the two types of waves referred to. Although it is possible that his conclusions may have to be revised in the light of improved data, and, it may be, improved methods of calculation, they appear to afford a fairly accurate estimate of the wave velocities from the surface down to a depth of more than half the earth's radius. Near the surface the two types have velocities of about 7.2 and 4 km. per second, respectively. These velocities increase almost uniformly as we descend, until a depth of one-third the radius is reached, after which, so far as they can be traced, they have constant values of 12.7 and 6.8 km. per second, which, by the way, considerably exceed the corresponding velocities in iron under ordinary conditions. The innermost core of the earth, *i.e.* a region extending from the centre to about one-fourth of the radius, remains somewhat mysterious. It can certainly propagate condensational waves, but the secondary waves are hard to identify beyond a

distance of 120° of arc from the source of disturbance. Knott himself inferred that the material of the central core is unable to withstand shearing stress, just as if it were fluid, but this must at present remain, I think, uncertain.

It should be remarked that the wave-velocities by themselves do not furnish any information as to the elasticities or the density of the material, since they involve only the ratios of these quantities. The relation between the two velocities is, however, significant, and it is satisfactory to note that it has much the same value as in ordinary metals or glass.

It is to be regretted that at present so little is being done in the way of interpretation of seismic records. Material support in the way of more and better equipped stations is certainly needed, but what is wanted above all is the co-ordination of such evidence as exists, the construction of more accurate tables, and the comparative study of graphical records. These latter present many features which are at present hard to interpret, and a systematic comparison of records of the same earthquake obtained at different stations, especially if these are equipped with standardised instruments, should lead to results of great theoretical interest. The task will be a difficult one, but until it is accomplished we are in the position of a scholar who can guess a few words in an ancient text, possibly the most significant, but to whom the rest is obscure.

Even on this rapid review of the subject, it should be clear that there is an apparent inconsistency between the results of two lines of argument. On one hand, the thermal evidence points to the existence of a high temperature at a depth which is no great fraction of the earth's radius, so high indeed as to suggest a plastic condition which would readily yield to shearing stress. On the other hand, the tidal arguments, as well as the free propagation of waves of transversal vibration at great depths, indicate with certainty something like perfect elasticity in the mathematical sense. The material with which we are concerned is under conditions far removed from any of which we have experience; the pressures, for example, are enormous; and it is possibly in this direction that the solution of the difficulty is to be sought. We have some experience of substances which are plastic under long-continued stress, but behave as rigid bodies as regards vibrations of short period, although this combination of properties is, I think, only met with at moderate temperatures. It is conceivable that we have here a true analogy, and that the material in question, under its special conditions, though plastic under steady application of force, as for example centrifugal force, may be practically rigid as regards oscillatory forces, even when their period is so long as a day or a fortnight. But beyond that we can scarcely, with confidence, go at present.

I have chosen the preceding subject for this address, partly because it has not recently been reviewed at these meetings, and also for the opportunity it has given of urging one or two special points. It is evidently far from exhausted—the loose ends have indeed been manifest—but this should render it more interesting. It furnishes also an instance, not so familiar as some, of the way in which speculations which appear remote from common interests may ultimately have an important influence on the progress of science. It is true that

the secular investigations into the form of the earth's surface have an importance in relation to geodesy, but certainly no one at the time of Laplace's work on this matter would have guessed that he was unwittingly laying the foundation of the whole mathematical theory of electricity. The history of science is indeed full of examples where one branch of science has profited by another in unexpected ways. I would take leave just to mention two, which happen to have specially interested me. It is, I think, not generally understood what an important part the theory of elasticity played in Rayleigh's classical determinations of the relative weights of the gases, where it supplied an important and indeed essential correction. Again, the mathematical theory of hydrodynamics, in spite of some notable successes, has often been classed as a piece of pure mathematics dealing with an ideal and impossible fluid, elegant indeed, but helpless to account for such an everyday matter as the turbulent flow of water through a pipe. Recently, however, at the hands of Prandtl, it has yielded the best available scheme of the forces on an aeroplane, and is even being appealed

to to explain the still perplexing problem of the screw-propeller.

To promote this interaction between different branches of science is one of the most important functions of the British Association, and differentiates it from the various sectional congresses which have from time to time been arranged. We may hope that this meeting, equally with former ones, may contribute to this desirable end.

Let me close with a local reference. The last fifty years have seen the institution of local universities and university colleges in many parts of Great Britain and of the Empire at large. Through these agencies the delights of literature, the discipline of science, have been brought within the reach of thousands whose horizons have been enlarged and their whole outlook on life transformed. They have become centres, too, from which valuable original work in scholarship, history, and science, has radiated. The University College of Southampton is now contemplating an increased activity and a fuller development. In this ambition it has, I am sure, the best wishes of us all.

Scientific Problems and Progress.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS OF THE BRITISH ASSOCIATION.¹

THE NEW IDEAS IN METEOROLOGY.

THERE have been great advances in the science of meteorology during recent years which have completely revolutionised our conception of the structure and mechanism of the atmosphere. Dr. G. C. Simpson devoted his presidential address to Section A (Mathematics and Physics) to a description of the chief of these advances, dividing his address into four parts, each dealing with one of the new ideas on which these advances are based.

(1) *The Thermal Stratification of the Atmosphere.*—By using the idea of entropy, Dr. Simpson showed that the atmosphere can be marked off into nearly horizontal shells which have the peculiar property that air which starts in any one shell cannot be transferred to any other shell and remain there in equilibrium unless heat is added or subtracted. Thus, in all atmospheric motion in which heat is neither added nor extracted, the air must travel along the shell in which it started. These shells act like physical restraints to the air, tending to prevent its moving in any but an almost horizontal direction. Occasionally the air contains sufficient water-vapour to supply, when it condenses, the heat necessary to pierce the thermal stratification, but these occasions are practically confined to thunderstorms and to the rain squalls in the doldrums. The thermal stratification of the atmosphere prohibits the ascent of warm air at the equator and descent of cold air at the poles which has generally been considered to be the cause of the general circulation of the atmosphere, on the analogy of a gigantic hot-water system.

(2) *The Mechanism of the Atmospheric Heat Engine.*—The old idea that the energy received from the sun is converted into the energy of winds by the air near the ground being warmed and rising, like the hot air in a chimney, is obviously unsound. The thermal stratification prevents this action in all but exceptional

cases. In place of this mechanism a new one is introduced. Masses of air from equatorial regions and from polar regions are brought side by side in middle latitudes. The cold polar air tends to subside and flow under the warm equatorial air which rises up the flank of the cold wedge which the polar air presents to it. When cold and warm air which were originally side by side react in this way, there is an appreciable lowering of the centre of gravity of the two masses taken together. Thus potential energy is released and appears as the energy of winds.

(3) *The Significance of Surfaces of Discontinuity in the Atmosphere.*—The surfaces at which relatively cold and warm masses of air meet and slide over each other as just described can easily be recognised on meteorological charts and by observations in the upper atmosphere. It is found that nearly all cloud is formed at such surfaces. Dr. Simpson discussed the conditions under which these surfaces of discontinuity can be maintained for long periods, and their significance in weather forecasting.

(4) *The Origin and Structure of Cyclones.*—The recent work of Bjerknes and Exner was described, according to which cyclones are formed where masses of air of polar and equatorial origin are brought together, and readjustment takes place in the manner described above. The old idea of a cyclonic depression being a kind of chimney drawing air in below and delivering it at the top can no longer be held.

These new ideas have had a far-reaching effect on the practical application of meteorology. Instead of the old empirical method of forecasting, the forecaster now has much more knowledge of what may be called the anatomy of a depression. He searches his charts for indications of the surfaces of discontinuity and examines the characteristics of the air masses to see whether they are of polar or equatorial origin. This has all resulted in greater confidence on the part of the forecaster, a confidence which is frequently justified by remarkably accurate forecasts.

¹ The collected presidential addresses delivered at the meeting are published under the title "The Advancement of Science, 1925," at 6s., or obtainable at the bookstall at Southampton by members at 4s. 6d.

THE CHEMISTRY OF SOLIDS.

IN his presidential address to Section B (Chemistry), Prof. C. H. Desch shows that the wonderful progress of physical theory in recent years has brought about a tendency to treat chemistry as a deductive science, the reactions of elements and compounds being deduced from the electronic constitution of their atoms. The chemical hypotheses of atoms, of molecular structure, of the benzene ring, of tetrahedral carbon, and of the periodic classification were devised in order to explain purely chemical observations, without reference to questions of ultimate reality, but modern physical investigations have shown them to represent Nature far more closely than their authors had supposed. This result should encourage chemists to continue on paths which have led to success before, rather than to base further work purely on an application of physical theory. The teaching of chemistry suffers from excessive and premature specialisation.

Attention is directed in particular to a comparatively neglected field of research, that of the chemistry of solids, by which are meant crystals and aggregates of crystals. The X-ray method has demonstrated the arrangement of atoms in crystals, and their mechanical properties have been extensively studied, but the relation between these and their chemical behaviour is obscure. The complication due to the unknown properties of the intercrystalline boundary may be eliminated by the use of single crystals, several of the metals having been prepared in this form. Reactions within a solid require the possibility of diffusion for their completion, and the evidence on this question is reviewed by Prof. Desch, as are the reasons for the variations of habit among crystals. Attempts which have been made to determine the distribution of the solute atoms in a crystalline solid solution by chemical means have led to the conclusion that isomeric solid solutions are possible. The study of the chemical properties of solids has been carried furthest in metallography, but is of importance also to chemical industry and to petrology.

CULTURAL ASPECTS IN GEOLOGY.

PROF. W. A. PARKS, in his presidential address to Section C (Geology), expressed the opinion that it is sometimes thought that the sciences are purely utilitarian and materialistic; they have, however, a high cultural value also in that they induce contemplation and bring their devotees into touch with the infinite. Geology, by reason of its breadth and its historical aspect, is particularly serviceable to this end. In both the organic and the inorganic worlds a tendency to greater and greater complexity is observed—from a universe of hydrogen to a maximum of chemical complexity, from a vibrant particle of protoplasm to man. The great age of the earth, probably 2,000,000,000 years, is a promise of still further duration, and the steady upward tendency of life is a promise of further development in the same direction.

Despite great geological changes, there have always been land and water, due to a marvellous nicety of adjustment between destructive and reconstructive forces. Similarly, although climatic changes have

been great, the temperature of the earth as a whole has been such that life has been possible from the earliest geological time to the present.

In the evolution of organisms, approximation to perfect adaptation is the herald of destruction. New races arise from less closely adapted stems, and the "missing links" are necessarily few and, owing to migration, are to be sought in stratigraphically oblique lines. Evolution is not brought about by some mysterious force acting on all organisms. The birth of a new phylum is a distinct event in time, and it does not bring about the extinction of the parent phylum. For example, sponges arose from Protozoa in the pre-Cambrian, and never since have the Protozoa fathered other than unicellular offspring.

Geological conditions govern most human activities, but those with a strong historical setting are particularly cultural. For example, a knowledge of the potential energy of Niagara Falls is not necessarily "culture," but that word may be applied to a recognition of the fact that Niagara Falls exist because some millions of years ago a layer of hard limestone was deposited over soft shales. The great principles of geology have had less effect on literature than might have been expected: this is particularly true of poetry. Among the major poets, Tennyson stands in first place in this respect. Strange to say, the principles of evolution and the great animals of the past seem to have inspired more doggerel verse than true poetry.

ORGANIC EVOLUTION.

IN his presidential address to Section D (Zoology), Mr. C. Tate Regan stated that his work on fishes has led him to the conclusion that the first step in the origin of a new species is the formation of a community, either with new habits or in a new or restricted environment. In Nature there is every gradation from morphologically identical communities to others so distinct that every one is agreed that they are well-marked species; thus the morphological discontinuity said to be characteristic of species is seen to be the final term of a habitudinal discontinuity that began with the formation of communities at first structurally similar. These ideas were illustrated by a detailed account of some species and communities of Salmonidæ.

The same principles apply to evolution in general; it has been adaptive; changes of structure have followed changes of habits, and especially changes of food and feeding habits. The origin and evolution of the neopterygian fishes illustrates well how modifications that were originally adaptive become historical; they persist, and become the basis for further adaptive modifications.

The natural selection theory is the only adequate explanation yet given of certain classes of facts; but it is a very unconvincing explanation of other classes, which lead to the conclusion that adaptive responses, repeated generation after generation, are consequently made earlier and more effectively. In the flat-fishes the cartilaginous bar above the eye that is going to migrate begins to be absorbed almost as soon as the fish is hatched, and while the fish is still externally symmetrical this bar becomes reduced to short processes of the otic and ethmoid cartilages, with a wide gap between them;

through this gap the eye migrates, so that when ossification takes place, one frontal bone is on the wrong side of its eye. This developmental history may be interpreted as the end result of a process initiated by the ancestral fish that first formed the habit of lying on one side, and tried to move the eye of the under side into a position where it could be of more use.

Many families of perch-like fishes, not at all closely related, have 24 vertebrae (10 praecaual and 14 caudal), and there is good evidence that this is a primitive percoid character. Here there is no variation, and therefore no material for selection, nor can any fish alter the number of vertebrae during its life by the way it swims. Yet it seems clear that this fixity has been broken through over and over again, and that the number of vertebrae has increased or decreased from 24 whenever it was necessary. Thus *Psettodes*, the most primitive flat-fish, structurally an asymmetrical perch, has 24 (10+14) vertebrae; it is piscivorous, and probably lies in wait and makes short dashes after fishes that come near enough. But other flat-fishes, which swim along the bottom with undulating movements, have many more vertebrae; the sole, for example, has about fifty. It seems that the muscular activities of a fish, its efforts to swim in a certain way, may produce a change in the number of muscle segments of its descendants. This may be condemned as a teleological speculation, but it is put forward as a hypothesis that fits the facts, and as preferable to the mutation hypothesis, which in effect states that it is only by accident that a structure has a function.

THE SCIENCE AND ART OF MAP-MAKING.

AFTER reference to Colonel Clarke as a distinguished citizen of Southampton, whose name is now to be commemorated by a tablet on the house where he lived, the president, Mr. A. R. Hinks, of Section E (Geography), expressed his lasting regret that Clarke's figure of the earth (1880) has not been chosen as standard by the International Conference at Madrid. With a glance at recent improvements in instruments Mr. Hinks discussed the modifications required in geodetic practice to cope with local attraction, referred to the intended reorganisation of time signals, and urged the establishment of British signals through the Imperial wireless chain. Dealing next with air-photographs and stereographic survey, he advocated reliance on ground stations, and an earnest attempt to apply the stereographic method to work on geographical scales. A summary of recent developments in map projections led to discussion of the International Map on 1/1,000,000, with the conclusion that its actual production should have been entrusted to a single establishment; that a smaller scale would have sufficed for much of the world; and that the work of the Permanent Committee on Geographical Names for British Official Use would be incomplete without a British map.

Turning then to the art of map-making, Mr. Hinks discussed the effect of multiple printings in colour, British pre-eminence in layer-colouring, and the need for some unproved mechanism for drawing or typing names. There has been a lamentable decline in the craftsmanship of both instruments and maps. The former dates from the application of the telescope, at an epoch when other crafts were at their highest point

of artistic merit. The decay in map-drawing came later, and may be repaired by diligent study and adaptation of early styles, rejecting the modern exaggerated use of distinguishing physical features by differences of lettering; but above all, avoiding sham medievalism.

THE MEANING OF WAGES.

IN discussing this extremely thorny problem in her presidential address to Section F (Economics), Miss Lynda Grier stated that no satisfactory theory of wages has as yet been formulated. Meanwhile, different interpretations of the word are accepted, varying with the aspects from which wages are considered. Wages are sometimes discussed as normal wages only, *i.e.* wages which represent the value of the work done under conditions of free competition. This value may be low, even when the work done is important and the workers do it competently, if there are many workers competing for a limited number of jobs and incapable of undertaking work of a different kind. When this is the case, the rest of the community gains by cheap services.

Frequently, however, wages are discussed as yielding an income which does or should maintain the worker. Up to a point the normal wage must supply sustenance in order to secure efficient workers. But it is not based on calculations of the length of the worker's life, of the cost of rearing him, of the size of his family, of the possibility of his death leaving a widow and children to be provided for. There is no necessity for employers to consider these things; few workers can afford to consider them. The normal wage takes account of the needs of the worker only when their satisfaction affects directly the supply or efficiency of labour. Beyond this point, needs are a weakness rather than a strength in bargaining.

Wage payments may be raised above the normal rate when demand for the product of labour is inelastic. In general, however, they can only be so raised by limiting the number of workers employed; the normal wage being the price at which all workers belonging to a particular grade can be employed in the occupations to which they are admitted. Attempts, legislative and non-legislative, to stretch wages to cover expenses not reckoned in normal wages are made at the risk of unemployment. Additions to low wages may be made with justice, since cheap labour which is not bad labour may provide cheap goods and since the worker is often not responsible for the cheapness of his labour. Moreover, all admit the necessity for some redistribution of wealth; but redistribution of wealth made in the name of wages may lead to a bad distribution of labour.

FIFTY YEARS' EVOLUTION IN NAVAL ARCHITECTURE AND MARINE ENGINEERING.

SIR ARCHIBALD DENNY, in his address to Section G (Engineering), traced the rise in the steam pressures used in marine engineering, and the passing from the simple to the compound engine, and from that to the triple and quadruple, which were practically universal in 1897. The appearance of the little *Turbinia* at the Spithead review in 1897 heralded a revolution in marine steam practice, which was at once embodied in the order placed by the Admiralty

in 1898 for the torpedo-boat destroyer *Viper*, and later in the mercantile marine, by the commissioning of the *King Edward* in 1901.

At first applicable only to the faster vessels, in 1909, after the conversion of the *Vespasian* from triple to geared turbine by Parsons, single gearing widened the scope of the turbine, and later double reduction gearing made it applicable to all types of sea-going vessels.

Dr. Diesel, who began developing the internal combustion engine for marine purposes in 1897, saw the fruits of his labours in trading vessels a few years before the War. Since the War, development has been exceedingly rapid, and indeed some enthusiasts claim that the days of the steam turbine are numbered for marine work. The reply of the steam turbine designer is higher steam pressures with superheat, pre-heating of the air to the furnaces, and stage heating of the feed water, etc.

There has been an enormous development in auxiliary machinery, both in the pursuit of economy and in providing for the greater comfort and convenience of the passenger and personnel. As to main engine power in any one hull, in 1875, 3000 I.H.P. was considered high, whereas now the highest in mercantile practice is 75,000, and in naval vessels 140,000 I.H.P. is found.

In the ship itself the changes in design and the growth in dimensions and draught have been many, while the developments in accommodation for passengers have been such that the third class of to-day travel at speeds and in a comfort which was not available to the first-class passenger of 1875, while now the first class have at their disposal all the comforts and luxury found "at home." Many changes in design were made possible when mild steel supplanted iron in the early 'eighties of last century, and present-day metallurgical researches make further advances probable.

Attention is directed to the various agencies which have assisted in the advances made, especially the influence of technical education, which in 1875, so far as workers in private works were concerned, was provided almost exclusively by evening classes under the guidance of the South Kensington Science and Art Department. The Admiralty, however, had much better provisions in the dockyards for their own students. The Admiralty training and the chairs in naval architecture which were later founded at three of our universities have had important influences on private works.

The regulations of the Board of Trade and the classification societies, and also the private and public research at the universities and at the National Physical Laboratory, especially in the Froude experimental tanks, of which there are now seventeen scattered throughout the world, have exerted important influences on shipbuilding. Finally, there are the technical institutions, such as the Institution of Naval Architects, which have had much to do with the development of design, while the effect of standardisation, under the guidance of the British Engineering Standards Association, is also discussed.

PRACTICAL ENGINEERING IN ANCIENT ROME.

DR. T. ASHBY discussed the remains of engineering works in Italy in his presidential address to

Section H (Anthropology), and stated that what appealed most of all to those who saw Rome in her prime were the aqueducts, the roads, and the drainage system. The Cloaca Maxima is ascribed by tradition to the Etruscan Tarquins, and (though nothing of the original structure is left) it still performs its functions, its splendid construction bidding defiance to the lapse of time: though, to our modern ideas, the direct discharge of sewage into the river seems dangerous.

Besides the drainage system, much attention was bestowed upon the regulation of the banks of the river and upon the bridges which crossed it. From there we pass naturally to the consideration of the road system, the nucleus of which dates from the beginning of Rome's history—of that wonderful network of roads which extended beyond Italy over the whole Roman Empire. Here, too (confining ourselves to Italy alone), we find a number of interesting and important engineering works. The Via Appia, the Via Traiana, and the Via Flaminia provide us with the best examples for study.

Turning last of all to the aqueducts, we find that the most important for our purpose are the four aqueducts which drew their supplies from the upper valley of the Anio, the Anio Vetus (272–269 B.C.) and the Anio Novus (A.D. 38–52), taking their supplies from the river the name of which they bear, the Aqua Marcia (144–140 B.C.) and the Aqua Claudia (A.D. 38–52), from springs which rise in the floor of the river valley. These aqueducts all required considerable restoration works, at more frequent intervals than one might have thought; and remains of the original channels of the two earlier aqueducts are rare, as indeed is to be expected, for they were built at a time when the danger of their being cut by an invader was still present.

As the course of these four aqueducts is often almost identical, the distinction of their remains was much facilitated by levelling operations carried out in 1915 by the late Prof. V. Reina; while Dr. Esther van Deman's researches on the chronology of the various types of construction employed in them are also of great importance. The remains are worth close study in detail; and the course of the aqueducts, which, when Prof. Lanciani's work was published in 1880, was still undetermined for several miles, has since been followed step by step, largely owing to his help.

These works of practical engineering seem to have been carried out by military engineers, who were at the same time civil architects—all of them Roman citizens, and for the most part Italians, not Greeks. The study of these works shows us that in this sphere, as in others, the Romans added very considerably to the sum of human achievement, and thus contributed in no small measure to make the condition of the human race what it is.

THE PHYSIOLOGICAL BASIS OF ATHLETIC RECORDS.

IN the records of athletics and of the various forms of racing there is a considerable store of accurate information as to the capacity of the human body for muscular effort, and the physiological basis of these achievements form the subject of Prof. A. V. Hill's presidential address to Section I (Physiology). The most complete collection of such information is to be

found in the "World's Almanac and Book of Facts," published by the *New York World*; similar, though not so extensive information, is to be found in Whitaker's Almanack. The manner in which athletic records can be explained by, and can be used to illustrate, physiological principles is best shown by plotting graphically the average speed at which a race is run as a function of the total time occupied in the race. In this way, for the various types of muscular effort involved, we may construct curves for the ideal individual, showing how long an effort of any required intensity can be maintained. For the shorter durations of effort, say up to twenty minutes, the form of the curve may be explained simply on the ground of the supply of oxygen, actual or potential, available to the competing individual. The muscular system works like an electrical storage battery in the sense that severe exertion may be undertaken for a time at the expense of oxidation (*i.e.* recharging) occurring afterwards in the recovery process. For anything but the shortest races, however, the amount of oxygen available in the contemporary supply through lungs and circulation is also of importance.

The following cases are considered: running, men and women; swimming, men and women; walking, rowing, bicycling, skating, and horse-running. Of these, running and swimming are almost precisely similar in their general relationships: both represent extremely rapid and violent exertion. Rowing, bicycling, and horse-running are different: the two former certainly, the latter probably, because the same extreme violence of exertion is not possible as in running and swimming. For efforts of greater duration, as in skating, bicycling, and in running and walking long distances, the determining factors are quite different from those concerned with the immediate usage and supply of oxygen. Here other types of fatigue, of a nature less understood at present, are at work.

The importance of skill in movement is discussed, and it is pointed out how the curve relating oxygen requirement to speed of movement gives a full and complete account, for any given individual, of the skill which he exercises in movement at any speed: the greater the oxygen requirement, the less the skill. Given a sufficient oxygen intake and a sufficient capacity for running up an oxygen debt, the chief factor in athletic effort of anything but the shortest duration is the skill and economy with which it is carried out. For the very short effort, economy is of less importance; the essential thing is to attain the greatest possible output of energy. Quite astonishing amounts of power are exerted by athletes in violent efforts of short duration.

SOME ISSUES IN THE THEORY OF "G" (INCLUDING THE LAW OF DIMINISHING RETURNS).

In his presidential address to Section J (Psychology), Prof. C. Spearman treated of certain points in a theory which has become known as that of two factors or of "g." According to this, every different ability of any person can be resolved into two factors, of which one is always the same but the other always independent; the factor always the same is intimately connected with what is commonly called "intelligence."

The proof falls into three distinct phases. The first

is to ascertain what are the conditions under which the measurements of any ability admit of such division into two factors. The second is to find where, if at all, these conditions are actually fulfilled. The third and last phase is that of supplying the factors with some serviceable explanation; the hypothesis which at present seems most helpful is that the "g" measures some particular form of "energy" derived from the whole cortex of the brain. Recently, the first phase was greatly advanced by discovering a new and much improved criterion of the divisibility called the "tetrad-difference." This has now been applied to the results of an actual experiment which furnished 3003 of these tetrad-differences. The median value of these as predicted by the criterion was 0.061; that actually found came to 0.062.

The second part of Prof. Spearman's address discussed the fact that in some abilities the "g" is predominantly influential, in others the "s." Now, evidence has been brought to show that the more any class of persons is well endowed with "g," the smaller becomes the influence of "g" as compared with "s." It would therefore seem as if the more energy is available already, the less advantage accrues from further increments of it. An interesting parallel to this is the economic law of diminishing returns.

In the third part of his address, Prof. Spearman showed that a great number of abilities, since they are dominated by the influence of "s," vary independently from one individual to another. The inference can be made that in respect of the great bulk of these abilities, every individual will tend to be near the average; a fair number will be distinctly above this, and a fair number below; at the extreme ends of the frequency distribution will lie a very small number of performances for which the individual is, on one side a genius, and on the other an idiot. To find out where the genius of each person lies is a work that seems likely to have extremely important results, educationally, industrially, and even socially.

THE PHÆOPHYCEÆ AND THEIR PROBLEMS.

THE Phæophyceæ or brown algae present a wide range of plant forms; in regard to external form and structure the higher members are the most highly differentiated of the Thallophyta, while in size they exceed greatly any green or red alga. In their reproductive schemes and life-histories they show striking differences, although the uniformity of their motile reproductive cells, the similarity of the colouring matter, and the products of assimilation indicate their descent from a common stock.

According to the presidential address to Section K (Botany) by Prof. J. Lloyd Williams, interest in the group has been much increased by recent work and also by Dr. Church's memoirs on the marine origin of the land flora. Much work has been done on the various bodies found in the Phæophyceæ cell, but the disagreement between investigators as to the nature, origin, and even the functions of these bodies, shows the need for further research. A similar state of affairs prevails with regard to our knowledge of the reproductive organs. The group, with its very divergent reproductive methods, is good material for a re-discussion of the theory of "alternation of genera-

tions," the various types ranging from Pylaiella, with fluctuating alternations of gametophyte and sporophyte, to Fucus, which is variously described as showing (a) alternations with extreme reduction of the gametophyte, (b) nuclear alternation of generations, and (c) no alternations at all, the plant being a gametophyte.

The address concluded with an appeal for increased study of the physiology and ecology of the brown seaweeds. No survey is available of the marine algæ of Great Britain, and there is also great need of an up-to-date English manual of the group.

THE WARP AND THE WOOF IN EDUCATION.

EDUCATION depends on a plan which includes the organisation and so much of the curriculum as is determined by the State, or by any other body in whom power is vested, and on the even more important contributions made by the teachers and by all the influences that surround the growing personality. The former is, according to Dr. W. W. Vaughan in his presidential address to Section L (Education), like the warp, the latter like the woof of the loom on which any fabric is woven.

The warp is at present probably too complicated, certainly too uniform, and it must remain too uniform so long as the State, for what were once quite good reasons, feels bound to define closely the powers of the local authorities, the boundary lines between education at different ages and of different sorts, and the limits of any city's or district's aspirations. What is now needed is that geographical units of reasonable size and homogeneity should be allowed to make real experiments, to set up warps of their own devising, receiving from the State in the way of grant what the State can afford to give and being allowed then to work out for that community a scheme of public education for the child, for the youth, and even for the man or woman.

In order that this may be done, we must get rid of some prejudices and some ideals that have been haunting us or are beginning to haunt us. One is that any extension of the school age must be uniform—applying to all children and to all places—another is that all are equally capable of fruitful education, another is that education cannot be won—and best won for some—by close contact with work that brings a livelihood, another is that education is to enable its recipients to have a happy leisure rather than to find happiness in daily work. The bogies, too, of wasted ability and thwarted genius must not be allowed to terrorise us. By all means do all that is possible—more indeed than is *done* now—to prevent waste, but do not let us be morbid in our fear of waste. Excellence depends on waste. Our careful precautions against waste lead to mediocrity.

The woof at which teacher or parent or employer or public opinion is always working depends on a more understanding co-operation between all those and all citizens too. For their goodwill alone can create the material circumstances in home and street that will prevent the influence of school being nullified by the influences that assail the impressionable mind in the hours of work, of leisure, and of recreation.

It is this co-operation that we teachers must ceaselessly implore and boldly claim.

THE MINERAL ELEMENTS IN ANIMAL NUTRITION.

IN his presidential address to Section M (Agriculture), Dr. J. B. Orr states that during the past half-century an increasing number of workers have become interested in the rôle played by inorganic salts in nutrition. Eight or nine of the mineral elements, *e.g.* calcium, phosphorus, potassium, etc., are known to be essential constituents of living matter. Iodine, manganese, fluorine, copper, zinc, and some others are found in traces. The presence of these was at one time thought to be accidental; it is now believed, however, that most, if not all, are essential constituents of the body.

The beginning of life-processes lies in the action of radiant energy on inorganic salts. The carbon atom is harnessed as the most suitable vehicle for conveying the chemical energy formed. The complex carbon-containing compounds, which have been regarded as the fundamental organic substances, are really secondary developments to secure that degree of stability and complexity required for the evolution of higher forms of life.

In the animal body, changes in the concentration of the inorganic ions in the circulating fluid are correlated with changes in functions of the organs. Thus, all the organs regulated by the central nervous system depend for the integrity of their function upon the maintenance of definite ratios of calcium, potassium, and sodium in the fluids within the nerve tissues. The classical experiments of Ringer on the perfused heart show that minute changes in the concentrations of calcium or potassium in the perfusing fluids have a profound effect on the activity of the heart. It is probable that the function of the bones in regulating the supply of mineral elements to maintain the "physiological balance" of the body fluid is as important as the more obvious one of providing a rigid framework. It is probably more fundamental, for when the available mineral matter is insufficient to maintain both the physiological balance in the blood and the rigidity of the skeleton, it is rigidity which is sacrificed.

When, for prolonged periods, the diet contains deficiencies or excesses of mineral elements greater than can be dealt with by the regulating mechanisms of the body, pathological conditions develop. It has been found that these occur not infrequently under modern conditions of intensive production in animal husbandry. Attempts to adjust the mineral content of diets by the addition of inorganic constituents that appear to be deficient meet, in many cases, with a marked degree of success. In the present stage of our knowledge, perfect adjustment is impossible. We need further information with regard to the amounts of each of the essential mineral elements required under different conditions, and the influence of the factors such as the "balance" of the diet and ultra-violet irradiation on the assimilation of mineral elements.

Valuable results are likely to be yielded by investigations on the interactions of colloids and inorganic ions, on the influence of the electrical charge and chemical characteristics of the ion on these reactions, on the effects of radiant energy on the processes associated with mineral metabolism, and on the relationship of these to both normal and pathological processes in the body. In this region there seems to lie the key to the solution of many obscure problems, both of the normal metabolism of health and of the abnormal metabolism of disease.



SATURDAY, SEPTEMBER 5, 1925.

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Cotton-Breeding, Plant Physiology and Agriculture.

KNOWLEDGE of the cotton crop presents a curious antithesis to that of wheat. The effects of environment are better analysed and understood for cotton than for most crops, but whereas the genetic study of wheat is classical, that of cotton is fragmentary. About cotton we have practically no "useless" genetical information, such as may suddenly turn out to hold the key to commercial difficulties, and a recognition of this ignorance has been a factor in founding the new Empire Cotton Experiment Station in Trinidad. So far, this lack of knowledge has mattered less than it might have done, because Nature provides the cotton-breeder with ample occupation in merely isolating pure lines from the complex population which arises from the small amount of natural crossing in cotton. Thus, almost no successful application of synthetic genetics has been made to cotton, except by Leake.

A further complication of cotton-breeding (and a further justification of the Trinidad scheme) lies in its inability to be a self-contained science. The cotton-breeder has one foot in the physiologist's camp so long as he deals with the inheritance of dimensional characters; and while cotton is grown as a paying crop for spinning purposes, its dimensional characters take practical precedence of all others. This may or may not be the right attitude, but at least we may be sure that the dimensions—if inherited at all as such—are not inherited in isolation. The writer had some glimmering of this when, in the dawn of Mendelism, he started to record every recordable characteristic in one hybrid cotton; his simultaneous observation that there were about two dozen chromosomes was damping to enthusiasm, even in those pre-Morgan days, and the study of dimensions led him by insidious paths into physiology. There is, of course, no antagonism between genetics and physiology in cotton; rather they are much too intimate, so that their disentanglement is quite difficult.

Some illustrations of this intimacy are provided by the report from the Bombay Presidency of the second annual Conference of Plant Breeders held at Surat last spring. The very first group of papers not only dived into physiology, but came out on the other side, with a discussion on the probable error of field experiments, an omnibus subject if considered for what it really contains, but yet an end in itself for the economic side of agriculture. The reputed instability of certain improved varieties when grown by farmers was next discussed; and, though traced to the obliteration of small superiorities by local conditions, it led to a

recommendation that "adaptability to a large range of conditions should be the ideal in breeding improved races." It is more than doubtful whether this ideal can be realised. Most species which adapt themselves to a wide range of conditions are complexes of elementary species, between which natural selection takes place on establishment in any fixed environment. When such elementary species, or similarly pure lines of cotton, are tested for various environments, they have been found by the writer to exhibit most decided local preferences; in one pair of Egyptian strains the long staple became short in the Sudan while the short became long; in another pair the yields crossed over when moved from Cairo to the cooler sea-board. Indeed, it seemed that if flexibility were wanted very badly, without abandoning the control of production-quality which pure lines give, then it would be necessary to issue blended seed containing more than one pure line. The suggestion may seem absurd; but with cotton it is in any case essential to have a seed-renewal system, so that after the lapse of some three years, when the blended strains have intercrossed to a serious extent, the bulk seed supply would be due for renewal from the pure stocks. It may be possible with some plants to eat one's cake and still possess it intact, but with cotton at least there seems to be a choice between putting stable pure lines into their appropriate environment or continuing to endure the inconvenience of unstable but plastic commercial "varieties."

A discussion on the possibility of standardising testing methods for different crops was held at Poona but does not seem to have been very helpful, as abridged in the report now before us. Testing as testing is a rather futile process, whether of crop yield, yarn elasticity or metal hardness; it can aim only at establishing comparable facts, which are incidentally and inevitably numerical. There is no test result known to the writer, in agriculture or textiles or engineering, for which he would not be glad to substitute an understanding of why the result was obtained. Without such understanding, even if imperfect, some of the factors implicit in the test method will escape control, and the comparability of the facts established will thereby be invalidated. More analytical, and much more physiological, was an account by Mr. M. L. Patel of the competitive effects of adjacent plants in the crowd of a field crop, and the differences from one strain to another in this respect.

Genetics as such does not appear until half-way through the Conference, with a note on natural crossing, also by Mr. Patel. The desirability of mass selection was then seriously questioned, though apparently without reaching the only definite conclusion possible,

namely, that while mass selection is the first thing to do, it is also the worst thing to do, and is simply a stop-gap expedient. We would like to hear more of the figures on which the next discussion was based, namely, "Acclimatisation and the Adaptation of Newly Imported Seeds." Few topics have been more thoroughly disintegrated than this by mere convictions, and any facts are of value. The Conference did not commit itself in its conclusion, which wags a reactionary tail; it considered that "acclimatisation was a fact and that it might be (1) selection by climate of like individuals from an obvious mixture, and (2) selection by climate of a physiologically suitable race from a variety apparently pure for all external characters, or the gradual adjustment of some individuals of a variety to a new environment, and that it is desirable to consider each case on its own merits."

It is clear that the plant breeders of the Bombay Presidency do not lack material for investigation, nor are they geneticists only. So far as can be judged from a brief report, it would seem that a useful service could be rendered to his fellows by some one who would dissect the complex story of plant-breeding into unit assertions—even if they were wrong—and definitions. To have two main meanings and several subsidiary ones, some mutually contradictory, for a single word like "acclimatisation," does not facilitate discussion with fellow-workers, or afford explanation to the outsider.

W. L. B.

Science at Oxford.

Early Science in Oxford. By R. T. Gunther. Vol. 3. Part I.: The Biological Sciences; Part II.: The Biological Collections. Pp. xii + 564 + 64 plates. (Oxford: The Author, Magdalen College, 1925.) 42s. net.

THIS splendidly produced and entertaining volume is the third of a series which Mr. Gunther has devoted to an account of the historic remains of scientific Oxford. They stand as a permanent memorial of the subject of which they treat. Like its predecessors, this volume is in the form of a catalogue, in which each heading is provided with a short introduction. It differs from the generality of catalogues in being extremely readable, and in the capacity that its author exhibits to lead the reader from point to point. Mr. Gunther is to be heartily congratulated on an achievement involving a most unusual combination of persistence, scientific knowledge in many departments, self-devotion, and literary skill and charm.

The history of science has two aspects, complementary one to the other. It may be treated from the point of view of the development of scientific ideas, the historian tracing these ideas in reference to one another and to

the cognate thought of the successive ages. This is the philosophical or psychological approach. The exponents of this method usually pay but scant attention to the "false starts" in science, they ignore almost entirely the by-paths of the subject, and are more interested in methods and results than they are in the men who use one or attain the other. On the other hand, the subject may be treated from the point of view of biography or of local history. This is the antiquarian or archaeological method. In the ultimate analysis it is philosophically indefensible, since the scientific process, of its very nature, demands that the search for truth must be carried on without prejudice to persons, and that truth, when found, must be taken for what it is, without regard to its origin. Science is the great leveller. Should she bow the knee to any idol, whether of the tribe, the cave, the market-place, or the theatre, she loses her divine right. But the antiquarian method is nevertheless very useful in another sense. By it alone can we learn of the social and intellectual environment in which science yields effective fruit, and—what is no less important—by it we can learn of some of those insidious factors that render science sterile. This knowledge is of evident practical application.

Mr. Gunther is an eminent exponent of the antiquarian method of scientific history. The value and interest of his results are undeniable. They have been justly greeted in his own University as containing a hitherto unwritten chapter in its long and varied history. Mr. Gunther is a genial and optimistic writer, a very loyal son of his *alma mater*, an admirable *raconteur* with a good eye and ear for the bizarre and ridiculous, which, however, never permit an interference with his enthusiasm for what is high and great. Nevertheless, reflection on the results of his work does not summon up thoughts that are consoling or cheering.

After enjoying these volumes, the contemplative reader will naturally ponder the end of all the endeavour that is there related. Since the Revival of Learning, four hundred years ago, a great University has been equipped with great endowments assigned to scientific ends. What have been the results? Let us discount the "amateur" who has ever borne an honoured place in British learning, but whose debt to his university has ended with his literary training. Let us put him aside and make a proper balance sheet: on one hand the endowments for scientific instruction, on the other the scientific achievements of those who have held, in this great and ancient University, the offices for the imparting of that instruction. Mr. Gunther rightly ends his book with a "Table of Succession of the Scientific Professors." It is the summary of the whole book, and is mournful reading. On the credit side a few really great scientific names will be discerned,

among them several of the founders of the Royal Society. But apart from the last generation or two, and excluding this limited number of brilliant exceptions, the succession is one of scientific nonentities, mostly men who do not take even a secondary place in the annals of science.

These fine volumes of careful studies thus bring out a fact that all interested in national education should take to heart. It is that the best manner of obtaining scientific results can by no means be easily determined. A very complex psychological question is involved. Pious founders in the past and in the present have often thought that they could obtain good results by mere monetary gifts to some particular department of learning. Men with affectionate memories of this school or that college seek to link the glory of an ancient foundation with that pure search for knowledge that can never be the property of a class or institution. These volumes show how much of this seed, thus strewn with careless and generous, if ignorant enthusiasm, has fallen and will fall on sterile ground.

The fact is that the production of an effective scientific atmosphere depends in the end on neither endowments nor institutions nor even good will, but on the intellectual outlook of society as a whole. The lesson is to help to create that outlook and the rest will follow naturally. The arrogant aloofness of the classical spirit of Oxford for centuries separated it from many of the movements that stirred the pulses of the people of England, and among them was the great scientific movement, the most important intellectual event of the last eighteen hundred years. Shame it is on our humanity and to the memories of its creators, the great minds of Greece and Rome, to call such a spirit "humanism"! The price—and it is a heavy one—has been most surely paid for being the home of lost causes. That phrase must not be lightly glossed as a mere joke or epigram. It is a diagnosis of a grave and deeply seated spiritual malady. From it Mr. Gunther's University emerged into convalescence only in quite modern times. His volumes will be read by posterity, but we believe that they will be read for the account that they contain of the course and symptoms of a very deadly disease.

The Technology of Glass.

A Text-book of Glass Technology. By F. W. Hodkin and A. Cousen. Pp. xxiii + 551. (London, Bombay and Sydney: Constable and Co., Ltd., 1925.) 42s. net.

FOR several years the glass industry of Great Britain has suffered from the lack of an up-to-date and authoritative text-book upon the technology of glass, but the deficiency has now been made good by

Messrs. F. W. Hodkin and A. Cousen. All interested in glass will welcome the recently published compilation of these two authors, and the industry owes them a debt of gratitude for such a masterly exposition of their subject, which covers the whole field of glass manufacture. Acting with admirable forethought, they have not stressed any one side of this manufacture above another, and throughout the work they have adhered to their determination as stated in the preface: to attempt no encyclopædic survey, but to allow the book to take the simpler form of a general introduction to the study of glass technology. In this they are to be commended, because the book becomes as valuable to the beginner as to the expert. The latter may indulge his desire for more detailed knowledge by reference to original papers and to books specified in a well-arranged bibliography and in copious footnotes, whilst the beginner will find each chapter easy to assimilate, there being no extraneous matter to confuse him.

The general arrangement of the volume will meet with approval, and it shows the stamp not only of experienced teachers but also of men who have a wide practical knowledge as well. Commencing with a chapter upon the historical development of the glass industry, the work naturally divides itself into sections upon physical properties, raw materials, fuels, refractory materials, furnaces and glass-making processes. No matter of importance is neglected, and each chapter is a mine of information upon the subject with which it deals. To those whose knowledge of chemistry is limited, Chap. ii. dealing with the basis of glass technology will be found helpful, as it indicates in a simple manner how glass is produced from raw materials. Chaps. iii., iv., v. and vi. upon the physical properties of glass, whilst of interest generally, are of particular import to those in whose domain lie the devising of new glasses and the improving of old. The question of thermal endurance is rightly stressed as this property is so important in every type of glass. The various factors which determine this endurance are also fully discussed. In this connexion, it would have increased the value of Table xv. to have included with the compositions of the glasses shown, the thermal endurance values calculated from the Winkelmann and Schott relation. However, the reader will find pleasant exercise in supplying the values for himself, using the various tables provided, which deal with density, tensile and crushing strength, elasticity, hardness, specific heat, expansion and the like. It may be said regarding these tables that one deprecates the omission of the values of Winkelmann and Schott for the elasticity factors of the various constituents of glass (see *Ann. d. Phys. u. Chem.*, 1894, p. 711, and 1897, p. 122).

One of the most valuable chapters in the book

(Chap. vi.) deals with the question of the durability of glass, and it provides a very thorough survey of the knowledge accumulated upon this important subject. A more detailed account of the apparatus used in testing for durability, together with diagrams of such apparatus, would not have been out of place and would have been found useful by manufacturers desiring to apply durability tests to their ware. In comparing the effect of sodium oxide and potassium oxide upon durability, "Peddle's generalisation" might well have been included, namely:

"In alkali—RO—silica glasses where RO is the oxide of calcium, barium, strontium, magnesium, zinc or lead, when the total alkali present is less than 20 per cent., a glass containing both alkaline oxides will be less soluble and more durable than the glass containing the same amount of alkali as sodium oxide or potassium oxide alone. This is true whatever amount of silica or RO is contained in the glass."

The raw materials of the glass industry are dealt with in Chaps. vii.-xii. The account given will be found full and up-to-date, in particular the pages dealing with the treatment of sands and the storage and mixing of batches. A special feature of this section is the tabulating of more than 100 batches for glass-melting, the mixtures given ranging over most of the best known types. To those who find difficulty in the calculation of batches for glass, Chap. xi. will appeal with especial force because the whole question of such calculations is treated in a very comprehensive manner. Purists will quarrel with the authors when they write " $\frac{1}{2}\text{K}_2\text{O}$," etc., thereby implying the "half molecule of a compound," but the expression may perhaps be tolerated in this chapter as it simplifies calculation considerably.

The authors deal with combustion and the evaluation of fuels in a very lucid manner, all the data being well marshalled and easy to assimilate. Chapter xiv., upon combustion, is rendered all the more valuable by the inclusion of typical calculations, and these are treated in a fashion which commands admiration. Throughout the volume, indeed, one cannot help being impressed by the facile manner in which calculations are worked out. In view of the increasing recognition of the value of temperature control in all glass-working processes, Chap. xvii., upon pyrometry, will arouse interest, and in it will be found a full account of the various devices for registering temperature in a glass works.

The sections of the work that will appeal most to actual manufacturers are those upon producers, refractories and furnaces. Chap. xix., dealing with producers, has only to be read to be appreciated, for it is a veritable storehouse of information. Pride of place among the four chapters (xx.-xxiii.) upon refractory materials must be given to that which

describes the manufacture of glasshouse pots and blocks, because of the series of fourteen photographs illustrating the production of a pot. Seven chapters in all (xxiv.-xxx.) are devoted to furnaces, and we have nothing but praise for the manner of treatment. Numerous diagrams and photographs enhance the value of these chapters, which deal in sufficient detail with many types of furnaces, lehrs, and so on, without being at all verbose, whilst the discussion is without bias. The principles of regeneration and recuperation receive full attention, and the respective merits and demerits of the two systems are emphasised.

The volume ends with nine chapters upon glass-making processes. This section will be of especial interest to the general reader as it serves to indicate the huge strides that have been taken during the present century in the manipulation of glass by machinery. The most modern processes are ably dealt with and a wealth of photographs and of diagrams is included. In this connexion it may be said that the whole book is admirably illustrated by more than 250 figures, many of them being full page in size.

The indexing will be found comprehensive, sections being devoted to name index and subject index, whilst a word of praise is due to the proof-reading, which has been very thorough. Very few errors will be met with in the text, and those of small importance.

Economy and Efficiency in House-Heating.

House Heating: a General Discussion of the Relative Merits of Coal, Coke, Gas, Electricity, etc., as alternative means of providing for Domestic Heating, Cooking and Hot Water Requirements, with Special Reference to Economy and Efficiency. By Dr. Margaret Fishenden. Pp. 296. (London: H. F. and G. Witherby, 1925.) 25s. net.

DR. FISHENDEN has provided one of the most interesting books that has ever been written on a most important branch of domestic science. Her work has been known for a considerable time to all those who are specially interested in the performances of domestic heating appliances, through valuable reports which have been issued from time to time by the Department of Scientific and Industrial Research. The contents of these reports have now been collected and expanded so as to give greater continuity and comprehensiveness of treatment, with the addition of critical historical matter, and a wide public owes a debt of gratitude to Dr. Fishenden for having undertaken the task, and having carried it through so well.

The book begins with a preliminary consideration of fuels available, their composition, and the methods of production of such artificial fuels as town gas and coke.

A brief summary of the position of electricity as a heating agent, and of the reports of the Electricity Commissioners in relation to power supply, terminates with the judgment: "At present, however, even the fact that most electric heaters give efficiencies of practically 100 per cent. theoretical, is not enough to counterbalance the low thermal efficiency and high cost of production."

Dr. Fishenden goes on to treat of the development of the modern sitting-room grate, and justice is done to Count Rumford, who was advocating at the end of the eighteenth century ideas applied in the modern fireplace, and to Dr. Pridgin Teale of Leeds, who enunciated detailed rules for the construction of fire grates, some of which are so generally adopted in the design of modern fireplaces that the author sets them out in full.

Then we begin to see the kind of thing that Dr. Fishenden has herself been doing in a paragraph headed "Fluctuations in the Rate of Burning of Coal Fires," accompanied by a number of diagrams indicating the variations in the intensity of radiation emitted from fires fed with coal, slack, and coke, stoked in different ways. A study of the distribution of radiation from open fires was carried out on the general plan adopted in the "Leeds" tests, described in the first and second Reports of the Joint Gas Heating Research Committee of the University of Leeds and the Institution of Gas Engineers. This chapter is very comprehensive. It is appreciative as regards the method employed by Prof. Boys in successfully burning gas coke on a flat firebrick hearth with an overhanging firebrick back, and the reverse of appreciative in dealing with the effect, or rather non-effect, of patent preparations on the efficiency of coal fires. The importance of providing draught regulation with coal fires is insisted upon, and the common error in the older open fireplace of drawing far too much air through the room is emphasised. The opportunity in installing a gas fire of realising a more efficient and economic arrangement in this respect is made very obvious. A corresponding treatment is then given to the development of the kitchen range, the survival of which is attributed to the fact that it can meet so many different requirements, although it functions so uneconomically with respect to any one of them. Dr. Fishenden's conclusion is: "It is probable that the independent boiler with open fire, with or without the addition of an oven, will gradually rise to a considerable degree of popularity, gas being used for cooking when no oven is included in the range."

The chapter on "The Development of Gas for Heating Purposes" is also very well done, and stress is rightly laid upon the ventilating effects of gas fires. In the discussion of room heating it is too often

forgotten that the fire and the flue into which it works are serving a double purpose, and that from the hygienic standard the ventilation is at least as important as the heating. Merely to warm the air in a room is insufficient, and in this lies the weakness of so-called "radiators" (which are mainly convectors), whether heated by steam or gas, and of nearly all the electric heaters.

An interesting chapter follows upon the use of gas for cooking purposes, in which the "Standard Gas Cooker" proposals of the Standardisation Committee of the National Gas Council are detailed, and the new gas cooker of Messrs Radiation, Ltd., with its semi-automatic controlling device, are both described along with more specialised devices, such as the Radiophragm heating introduced by Prof. Bone specially for toasting or grilling operations.

As regards the efficiencies obtainable in gas heating and cooking appliances, the results of the Gas Investigation Committee of the Institution of Gas Engineers and the University of Leeds in Britain, and those of the Bureau of Standards in the United States, are widely quoted.

Electricity for heating, cooking, etc., is given a chapter to itself, Dr. Fishenden pointing out that "modern electrical cookers, like electrical heaters in general, can be considered to owe their origin to the discovery of nickel-chromium high resistance wires," which stand long contact with air at high temperatures. Various types are discussed, and then in another short, but interesting, chapter the position of central heating by various methods is indicated and briefly discussed.

In many ways the most important and useful chapter of all is that which brings the book to a close, but it is not easily summarised. It is to be hoped, however, that this impartial and well-informed summary by a competent authority, who has given special attention to the subject, will be widely read, even by those who have not the time or perhaps the inclination to read the more detailed considerations of the preceding chapters. It is a statement and an expression of reasoned opinion which comes at a time when it is very much wanted, in the first place, because a combination of circumstances is persuading or compelling householders to find out what are the most economical, cleanly, and healthy methods applicable for carrying out the heating operations required in their homes, and secondly, because without such information it is only too likely that catch-words may take the place of principles in forming public opinion and inducing legislative action.

The reviewer does not mean that he would necessarily endorse in detail all the statements and conclusions made in this chapter, but he does regard it as an excellent attempt at summarising a very complicated

matter. Dr. Fishenden begins by taking the costs of different fuels which would be sufficient, if completely burned, to produce one therm (or 100,000 B.Th U.), and then, with reasonable assumptions as to comparative efficiencies, points out that "with coal at 50s. per ton, gas at 10d. per therm and electricity at 1d. per Board of Trade unit, an up-to-date open gas fire would cost about two and a half times as much as an open coal fire, whilst an electric heater would cost about five and a half times as much. But it must be clearly understood that in this comparison equivalent heating values during continuous running have been the basis, and no allowance has been made for the saving in labour effected by the use of gas or electricity as compared with coal." For intermittent use, of course, the conditions become much more favourable for the more easily controlled methods of heating. "In practice, owing to the fact that coal fires cost an appreciable amount to light, and involve a great deal of work in the carrying of coal, cleaning of grates, etc., gas fires for such periodic heating would generally prove to be decidedly cheaper than coal fires. And even electric heaters, on the relative costs which have been taken, would sometimes, by their convenience and adaptability, repay for the higher cost of the units used."

One of the most useful portions of this chapter is that in which the author considers in turn heating appliances for large and small houses and for cottages, discriminating wisely between the requirements of one and another. Her final sentence is "For almost every purpose which raw coal at present fulfils, smokeless domestic cokes would prove a satisfactory substitute, and used in conjunction with gas or electricity would enable all domestic heating, cooking, and hot water requirements to be carried out economically, with a complete absence of black smoke production."

One criticism the reviewer must make. This book is very well printed, and the diagrams are numerous and clear, but it is surely a book for which a large circulation should be sought, and the price asked will scarcely allow of that object being attained. JOHN-W. COBB.

The Morphology of Crustacea.

Studies on Arthropoda, II. By Dr. H. J. Hansen. (Published at the expense of the Rask-Ørsted Fund.) Pp. 176 + 8 plates. (Copenhagen and Berlin: Gyldendalske Boghandel, London: Constable and Co., Ltd., 1925.) 15s. net

SO long ago as 1893, Dr. H. J. Hansen published in the *Zoologischer Anzeiger* a preliminary paper on the morphology of the limbs and mouth-parts in crustaceans and insects. Many of the views adumbrated in that paper have since been adopted and developed by others, and some of them have been

further illustrated by the author himself in the course of systematic papers dealing with the varied groups of arthropods which he has studied. Now, after more than thirty years, we have the first part of the connected exposition of his morphological views, for which the earlier paper was to prepare the way. In this memoir, only the Crustacea are dealt with, the remaining divisions of the Arthropoda being reserved for a future part.

So far as it is not purely descriptive, Dr. Hansen's point of view may be said to be that of an idealistic morphology. He abjures phylogenetic speculation, and has nothing to say as to the structure of hypothetical ancestral forms. This was also the point of view of the great protagonist of Darwinism, whose centenary we have recently been celebrating. It was Huxley's opinion that "morphological generalisations . . . will remain true, so far as they are true at all, even if it should be proved that every animal species has come into existence by itself and without reference to any other." It may perhaps be doubted, however, whether even Huxley was able to keep his morphology quite untainted by evolutionary speculation. Try as we may, we cannot look at things with the eyes of the pre-Darwinians, but it is right that we should be reminded how much in our phylogenies is sheer guesswork and how little justified is the confident dogmatism of "Haeckelismus."

Dr. Hansen describes in great detail, and illustrates in a series of finely engraved plates, the chitinous exoskeleton of the mouth-parts and limbs in the main subdivisions of the class Crustacea. He brings much additional evidence in favour of the view, now accepted by many authorities, that the sympod (protopodite of Huxley) is typically composed of three, instead of two segments. In the thoracic legs of Decapoda he finds that an additional segment, first observed by Coutière and here termed "præischium," is often indicated, and he bases on this a new scheme of comparison of the segmentation of the legs in the various orders of the Malacostraca. In this scheme the position of the "knee," or main flexure of the limb, is assumed to remain constant throughout the sub-class. On this point it is perhaps permissible to doubt whether the evidence is quite conclusive.

Dr. Hansen has no doubt that the trilobites should be regarded as Crustacea, rejecting, probably with justice, the arguments against this view drawn from the absence of a shell-fold and the sessile condition of the eyes. He thinks it impossible that the limbs can have been articulated, in the way described by Raymond and Walcott, to downgrowths of the dorsal skeleton, and, indeed, such a mode of articulation would be without parallel among recent arthropods.

In dealing with the Cirripedia, the interesting suggestion is put forward that the so-called "mandibles" of the adult may be the maxillulæ, the mandibles being lost in the course of development. This point might well engage the attention of embryologists.

Great importance is attached to Geoffrey Smith's description of a biramous mandibular palp in *Paranaspides* as giving the clue to the interpretation of the palp in other Malacostraca. No subsequent observer, however, has been able to see a trace of the biramous condition in *Paranaspides*, and there can be little doubt that Geoffrey Smith was misled on this point.

Many other points of general morphological interest are discussed in the course of this memoir, which deserves the close attention of all students of the Arthropoda.

W. T. C.

Education of Chimpanzees.

The Mentality of Apes. By Prof. Wolfgang Köhler. Translated from the second revised edition by Ella Winter. (International Library of Psychology, Philosophy and Scientific Method.) Pp. viii + 342. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1925.) 16s. net.

PROF. KÖHLER'S book marks a distinct advance in comparative psychology, for he was able to study his chimpanzees in very favourable conditions of health and housing in Teneriffe. He also realised that these apes are characteristically social creatures and must be studied in companionship with their fellows. A chimpanzee is intellectually and emotionally bewildered if it is kept in solitary confinement. "It is hardly an exaggeration to say that a chimpanzee kept in solitude is not a real chimpanzee at all." Prof. Köhler's experiments were also marked by their critical carefulness. No emphasis is laid on single incidents; the crucial experiments were repeated many times. Generous descriptions were for the most part rejected.

The book gives abundant evidence of genuine intelligence or power of perceptual inference. Thus a chimpanzee will pile one box on the top of another to the number of four, in order to reach a banana fastened to the roof of the cage. In the course of a forenoon a clever chimpanzee discovered how to fit a short bamboo rod into the end of a longer and broader one, so that it was able to reach a prize lying beyond the bars. Even more striking was the prolonged biting at an unsuitable piece of wood so that it could be fitted into the bamboo rod, thus making a double stick. The apes often showed very precise observation, for example, of the spot on raked and featureless ground where they had seen some treasure

buried. They recognised their teacher or a companion after prolonged absence, though on the whole, out of sight is out of mind to a chimpanzee. A conspicuous feature was the restless inquisitiveness; it often seemed as if they liked trying for trying's sake. They would feed the hens with bread which they themselves were not fond of, and would watch the details of the pecking with great interest—obviously the beginning of chimpanzeeish ornithology. This they would prosecute by luring a hen close to the cage and then suddenly giving it a dig in the ribs with a stick. Very quaint was the appreciation of a hand-mirror and the passage to the use of other things as mirrors, such as pieces of metal or even a pool of rain-water, at which they would stare long and intently, just as if self-consciousness was dawning. Yet in spite of long-continued experiments, the apes never got away from the conviction that there was an elusive "other fellow" through the looking-glass. For him they would lie in wait and at him they would make many a sudden pounce!

The particular limitations of chimpanzees seem to be their poor vocabulary and their slight capacity for working with "images" in the mind. They solved many problems, such as those we have mentioned, but one condition of success is that they must be brought into circumstances where the factors that constitute the solution are all visibly given. They must have all the facts of the case within their visual range. The book seems to us a very valuable one: its net result is to show that chimpanzees are very ingenious within a narrow range.

Our Bookshelf.

The Production and Measurement of Low Pressures.
By Dr. F. H. Newman. Pp. 192. (London: Ernest Benn, Ltd., 1925.) 16s. net.

IN recent years the advance of physics, especially atomic physics, has required vacua of an ever-increasing perfectness; to this end a series of extremely ingenious methods and pieces of apparatus have been designed, most of which have only been developed after the fundamental principles underlying each of them were fully mastered. At the same time manufacturers have availed themselves of these improved methods, and it is now common practice that methods of exhaust of the most recent type are employed in the production of commercial articles which require to be exhausted to the very highest degree. In order to be able to measure such high vacua, gauges capable of such precise measurements have been developed, and it is, of course, only by advancing such means that the process of exhaust can be improved.

Prof Newman in his book has given a very good description on both parts of this subject; after a short historical résumé, he has given an excellent account of

all modern high vacua exhaust apparatus, which will certainly be of great use to all concerned in such work, and from a large number of tables (some of which possibly might have been better expressed as a curve) has afforded the physicist or the vacuum engineer a sound basis from which he will be able to choose the type of apparatus suitable to his work.

The effect of the size and length of connecting tubes on the rate of exhaust is dealt with and the importance of these factors is shown by a few examples. There is a chapter on "Sorption," giving a good résumé of the most important papers which have been published, after which comes an interesting chapter on "clean up," the process which plays such an important part in the modern methods of lamp and valve manufacture.

The second section of the book deals with the measurement of pressure. Here the different methods are fully described—each one being given space according to its practical uses or for its fundamental importance. A chapter describes the exhaust procedure in which is emphasised the care which has to be taken in the freeing of the container walls and electrodes from gas. Prof Newman's short account of making glass to metal joints shows that he is unaware of the ease with which such seals are now carried out on a technical scale even up to a diameter of several inches. As a whole the book is an excellent one and will be welcomed by all who are interested in the subject. R. L. E. R.

The Indo-Sumerian Seals Deciphered: discovering Sumerians of Indus Valley as Phœnicians, Barats, Goths and Famous Vedic Aryans, 3100-2300 B.C.
By Dr L. A. Waddell. Pp. xxiv+146. (London: Luzac and Co., 1925.) 10s. net.

COL. WADDELL, the well-known authority on Tibet, has stepped in where archæologists, as yet, fear to tread. He has produced an interpretation of the remarkable seals which were found, with other relics suggesting an affinity with ancient Sumeria, at Mohenjo Daro and Harappa in the Indus Valley, and illustrated and described by Sir John Marshall, Director of the Archæological Survey of India, in the *Illustrated London News* in September of last year. "Within a day or two of receiving the photographs," says Col. Waddell, "I was able . . . to decipher and read the greater part of the inscriptions on the seals."

According to Col. Waddell's interpretation, the seals provide a record of the rulers of a Sumerian colony in the Valley of the Indus of the third millennium B.C. His system of interpretation is revolutionary and entails a complete revision of the results obtained hitherto in dealing with Mesopotamian records. Detailed discussion of his conclusions would therefore be unprofitable without previous acceptance of the argument by which he justifies his method of attacking the problem. This is based upon theories which have been expounded in part, though not entirely, in a previous publication in which an attempt was made to prove, not only that the Phœnicians were the ancestors of the Britons, Scots and Anglo-Saxons, but also that they were Aryans and the ruling Aryan class of India. The kings of the early Aryan dynasties of India, it was maintained further, had never been in India, but were kings in western Asia and were to be identified with the kings of early Mesopotamia—Sumeria and

Akkad Col. Waddell regards the seals as confirming his theories; but it must be obvious that an interpretation which is entirely individual depends upon, rather than confirms, a theory which still lacks conclusive demonstration. For it must be stated that Col. Waddell's views, particularly in so far as his etymological arguments are involved, have not met with the acceptance of those most competent to judge. Until the author has brought forward more cogent arguments for the identification of the kings of the Indian lists with those of Mesopotamia—a subject with which it is understood he proposes to deal in a later work—the riddle of the seals remains unsolved.

Aufgaben und Lehrsätze aus der Analysis. Von Prof. G. Pólya und G. Szego. (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen, Band 19 und 20) Erster Band: Reihen, Integralrechnung, Funktionentheorie. Pp. xvi+338. 15 gold marks. Zweiter Band: Funktionentheorie, Nullstellen, Polynome, Determinanten, Zahlentheorie. Pp. x+407. 18 gold marks. (Berlin: Julius Springer, 1925)

Most French and German mathematical text-books differ from the English books in one important particular: they contain no examples for solution. The working of problems and examples has long been one of the features of English mathematical teaching. All able mathematical students of a generation ago were expected to gain practice in manipulation by solving hard problems. Wolstenholme's problem book reflects the tendency of the period in which it was compiled, a large proportion of its examples being somewhat artificial in character despite the elegant solutions they admit. Now the tendency is to avoid problems involving hard manipulation, it being considered that familiarity with mathematical subjects can be gained by working easy examples constructed to test a student's knowledge of fundamental principles. The new Wolstenholme still remains to be written.

Meanwhile, Prof. Pólya and Herr Szego, in the two volumes before us, have brought together some 1500 problems dealing with the subjects of analysis above noted. A large proportion of the questions can be solved at sight; others involve results taken from research papers in the journals, and few readers will see through these without referring to the solutions. The books will be of great value to honours students of pure mathematics in universities, and a lecturer will find innumerable suggestions for examples to set before his classes. W. E. H. B.

Air Ministry: Meteorological Office. British Meteorological and Magnetic Year Book, 1917. Part 5: *Réseau Mondial, 1917.* Monthly and Annual Summaries of Pressure, Temperature, and Precipitation at Land Stations, generally Two for each Ten-degree Square of Latitude and Longitude (M.O., No. 229 g, Tables) Pp. xiv+116 (London: H.M. Stationery Office, 1925.) 22s. 6d. net.

THIS publication deals with the weather results for the whole globe, and similar results are now available for the eight years 1910-1917. The means are compared with normals and the differences are given for each element for each station. The statistics for each additional year add much of real scientific value in the

direction of preparing for long-period forecasts. It is now possible to see how excess or defect from the normal in one part of the world influences weather experienced in another part. It is a fairly simple study to ascertain whether the pressure of the air at the earth's surface is practically uniform at different times over the whole globe. All the information refers to land stations, no data over the sea being as yet obtainable. The number of stations utilised is 458, which is an increase of 18 since the previous issue for the year 1916.

The highest mean shade temperature for the year 1917 was 87° F. at Sokoto and 86° F. at Berbera, Somaliland; the lowest mean 6° F. at Verkhoiansk. The absolutely highest shade temperature recorded is 123° F. at Baghdad on July 21 and at Jacobabad on June 11; the absolute lowest temperature was -81° F. at Verkhoiansk on January 19. The heaviest total rainfall for 1917 was 9850 mm (388 in.) at Cherrapunji, the least 1 mm. at Iquique.

Schlich's Manual of Forestry By Sir William Schlich. Vol 3: *Forest Management, including Mensuration and Valuation.* Fifth edition, revised, and the greater part rewritten. Pp. viii+383. (London: Bradbury, Agnew and Co., Ltd., 1925) 20s. net.

IN this fifth edition of vol. 3 of Schlich's "Manual" the number of pages is slightly less than in its predecessor. Room has been found, however, for a considerable mass of new material, and for several new figures, by judicious compression and elimination, so that the work is brought up-to-date with the examination of new ideas and practice in forestry. Those who peruse the several publications devoted to the science of forestry in England and in India are aware that the author has kept in touch with the latest developments, and here he brings to bear his keen faculty for criticism and for the correct appreciation of modern tendencies.

All the features and main divisions of the previous edition are retained and improved. Among the added subjects the British Forestry Commissioner's method of determining the volume of whole woods is described and criticised. Sir William's own graph for indicating the mean forest per cent., first published by him in his pamphlet "Forestry in the United Kingdom" in 1904, is now included, as well as a reference to Mr W. S. Hiley's indicator graph, and among the modifications of the compartment system, Dr. Eberhard's ingenious system of wedge fellings is discussed. The controversy on the question of the rate and kind of interest to be adopted in forestry has led to the inclusion of a paragraph explaining why the application of compound interest in forest finance is insisted upon.

The volume is produced in the now familiar, neat, and handy form of the former editions, and should find place on the reference shelves of every scientific forester. C. E. C. F.

A Survey of Physics: a Collection of Lectures and Essays. By Max Planck. Translated by R. Jones and D. H. Williams. Pp. vii+184. (London: Methuen and Co., Ltd., 1925.) 6s. net.

Messrs. Methuen are doing a real service to science by their publication of translations of foreign scientific works, but they are not always fortunate in their choice of books for translation. It might have been thought

in a book with so attractive a title and by such an eminent scientific worker they had a real certainty. The book itself, however, somewhat disappointed our, perhaps unduly great, expectations. It is a collection of lectures and addresses, delivered on different occasions and at different times, mainly on the thesis that physics has now reached the stage when the attempt to form a mechanical picture of natural processes, which has engrossed the attention of the great physicists of the past, should be definitely abandoned, and we should satisfy our souls with the subtleties of thermodynamics and the search for an all-embracing formula. The author develops his thesis forcibly and ingeniously though, necessarily from the structure of the book, with some repetition, and the book should prove attractive to those interested in the philosophy of science. To the physicist the most interesting chapter is that in which the author sketches the road by which he arrived at the quantum theory. The translators have not always been happy in their rendering of the original. We, at least, had some little difficulty in recognising in "Thales von Milet" our old friend Thales of Miletus.

Joule and the Study of Energy. By Dr. Alex. Wood. (Classics of Scientific Method) Pp. viii+88+8 plates. (London: G. Bell and Sons, Ltd., 1925.) 1s. 6d. net.

THIS excellent little volume could be read not only with profit but also with pleasure by all students of physics from the school-boy stage upward. There is no better way of appreciating the meaning and value of a scientific principle than a study of the ways in which it was evolved, and no better way of gaining a real understanding of scientific method than a study of the work of one of the great pioneers of science. In something under ninety pages, Dr. Wood succeeds in giving a clear and adequate outline of the gradual growth of the conception of energy, and a lucid account of the work of Joule on the mechanical equivalent of heat, illustrated by ample quotations from Joule's papers. At the same time, he finds room for those humanising touches of anecdote and biography which give life and colour to a work of this kind, and the numerous well-chosen illustrations add still further to the interest.

Dr. Wood has a high reputation as a lecturer, and he writes as charmingly as he speaks. Students of physics should certainly read and enjoy the book, but so clear is the exposition that those who, without being students of physics, are interested in scientific thought and method, could read it, we believe, with almost equal pleasure and interest. The editor of the series is to be congratulated on having persuaded Dr. Wood to write this book (we wish he had allowed him to write the general introduction also), and the publishers on producing it in such an attractive form and at so reasonable a price.

Smoke: a Study of Town Air. By Prof. Julius B. Cohen and Dr. Arthur G. Ruston. New enlarged edition. Pp. xii+108+15 plates. (London: Edward Arnold and Co., 1925.) 8s. 6d. net

THE second edition of Prof. Cohen's and Dr. Ruston's book on "Smoke" is modelled closely upon the first. It has, however, some important additions on the effect of smoke on vegetation, and a new section has

been added—"The Plant as an Index of Smoke Pollution." There is much useful information on the nature, quantity, and effect of soot, based mainly upon Prof. Cohen's own observations made in Leeds and its environs some years ago.

The chapter on "Town Fog" can scarcely be taken as setting forth the latest knowledge on the subject. For example, in describing the initial stages of condensation to form particles of mist or fog, p. 66, the vital distinction between the influence of ordinary dust and of hygroscopic salts is neglected, and ordinary dust is credited with an effect on condensation which it does not possess. Similarly, Aitken's "dust" counter is now known to take cognisance of hygroscopic nuclei only, neglecting ordinary dust. Yet this fact is not brought out when it is compared with the Owens' dust counter; the latter is incorrectly described as a modification of Aitken's, although based on a different principle and counting different particles. Again, the conception of a town fog as formed by condensation on "every little floating particle of dust" is not in accordance with the present state of our knowledge.

There is a little obscurity in the phraseology in plan (p. 27), but, on the whole, the book is a welcome contribution to the study of the air of our cities, the need for purifying which is becoming more apparent as such investigations lay bare the far-reaching ramifications of the smoke evil.

The Ao Naga Tribe of Assam: a Study in Ethnology and Sociology. By Prof. William Carlson Smith. (Published by direction of the Government of Assam.) Pp. xxvii+244+8 plates. (London: Macmillan and Co., Ltd., 1925.) 21s. net.

THE Aos, the people studied in this latest addition to the excellent series of monographs published by the Government of Assam, occupy the country lying between the Lhota and Sema Nagas on the south, and the various Naga tribes, collectively known by the Aos as "Miri," in what is mainly independent territory on the north. The Aos are composed of two racial groups, the Mongsen and the Chongli, which Mr. J. H. Hutton in his interesting introductory analysis suggests may have fused comparatively recently, the Mongsen representing a pre-Ao population. The author modestly does not claim for his book that it is any more than an introduction to the study of the people. He has covered a wide field in his account of the culture, social organisation, and religion and magical beliefs of the people, but not in that intensive manner which we have become accustomed to look for in this series. What is, perhaps, the most valuable part of the book, especially from the practical point of view of the future of the people, is the final chapter recording the changes in their culture which have been brought about by contact with outside, and especially European, influences. It is both a guide and a warning.

Nutrition de la plante. 4: Cycle de l'azote. Par Marin Molliard. (Encyclopédie scientifique: Bibliothèque de Physiologie et de Pathologie végétales.) Pp. xv+319. (Paris: Gaston Doin, 1925.) 15 francs

A SUBJECT which has attracted the attention of botanist, chemist, and bacteriologist alike is bound to be unwieldy and its literature difficult to survey in a book of three hundred pages. Especially is this the case

when, being part of a scientific encyclopædia, it must presumably be intelligible to those whose general scientific knowledge is only limited. From this point of view, the book is well written, and the author, while necessarily introducing a good deal of text-book matter—as in Chap. i., which deals largely with tests and properties of various nitrogen containing compounds—has yet found space enough to make reference to more than two hundred original papers. These have been well surveyed, and, in most cases, actual experimental numbers are given. The various stages of the cycle are worked out somewhat on monograph lines in Chaps. ii-v under the self-explanatory headings of nutrition, digestion, and transformation. The sixth and last chapter is devoted to the *bêles noires*, or those nitrogen containing bodies which do not find a definite place in the cycle. The conflicting data and opinions of various authors are given, and the reader advisedly left to form his own. A complete bibliography concludes a very readable and useful book. E. R.

The Lilies of Eastern Asia: a Monograph. By Ernest H. Wilson. Pp. xiv+110+17 plates. (London: Dulau and Co., Ltd., 1925.) 25s. net.

It is not often that a writer on plants has the advantage of having had experience of seeing them in their native habitats, of cultivating them, and of studying them from herbarium material. Mr. Wilson is fortunate in having combined these, and shows in his introduction what good use he has made of his opportunities, so as to arrive at an estimate of the value of the various characters for taxonomic purposes. He has made three journeys through those parts of eastern Asia which may be regarded as the headquarters of lilies, and has also studied the material preserved in the chief herbaria of the world. The result has been the production of a volume containing detailed descriptions of the species and varieties, references to literature and synonymy, indication of habitat and notes on their cultivation, together with seventeen plates, of which several are reproductions of photographs taken by the author, of the plants in their native habitats. The book will be of great assistance to students of lilies, and gives references to the scattered literature which has accumulated since the publication in 1880 of Elwes' "Monograph of the Genus *Lilium*."

C. H. W.

Wireless Valve Transmitters: the Design and Operation of small Power Apparatus. By W. James. Pp. viii+271+8 plates. (London: Iliffe and Sons, Ltd., 1924.) 9s. net.

THE aim of the author is to deal in turn with the various parts of a complete radio transmitting equipment so as to enable the amateur to set up and operate his own transmitter. A great deal of interesting and instructive work can be carried out by a "non-radiating" aerial, and certainly this type should be used by the beginner. The circuit arrangements described are either standard practice or of proved practical utility. The author's diagrams make his descriptions easy to follow. Those whose experiments are carried out mainly by trial and error will do well to read this book. Amateurs have recently had many successes to their

credit, and they deserve every encouragement. Rigorous mathematicians would not allow some of the proofs given in the book. For example it is stated (p. 7) that the skin effect is greater the larger the cross-section (S), the higher the frequency (f), and the better the permeability (μ). It is less for conductors with a high specific resistance (ρ). "Thus" the skin effect is proportional to $S\mu f/\rho$. It is conceivable that some readers might think that this was a proof.

Choosing your Life Work. By William Rosengarten. Second edition. Pp. xxii+323. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 12s. 6d. net.

THIS book sets out with the aim of helping a young boy to choose a career. According to the author, psychological tests are so new and uncertain that for practical purposes they are almost as untrustworthy as phrenology and physiognomy. Therefore the youthful aspirant for a career is recommended to analyse himself according to the *questionnaire* appended and then to turn to the various occupations and select according to his fitness. A chapter is devoted to each of the common occupations, and the requirements, emoluments, and drawbacks to each are described. It is distressing to learn that the telegraphist, although he fulfils a very important function, is unlikely to win high financial reward. As a handbook to various trades, the book may be useful; its style is verbose and the information it gives would not have been impaired by judicious compression. The blend of moral "uplift" and commercialism is not attractive to the English reader.

The Dust Hazard in Industry. By Dr. William E. Gibbs (Chemical Engineering Library: Second Series) Pp. 168. (London: Ernest Benn, Ltd., 1925.) 6s. net.

THE subject dealt with in this book is one of great importance. Industrial dust is frequently a source of danger, either to health, or to life and property by causing explosions. Although much valuable information is available, the publications are scattered, and the author has performed a useful service in collecting and arranging the material in a readable form. Particular attention is paid to dust explosions, on which much useful information has been obtained at the Home Office Experimental Station at Eskmeals. American results, of great value, have also been fully considered, and the book is authoritative. Some of the information will be of interest to medical men as well as to chemical engineers. The name of the chief authority on explosions, Prof. H. B. Dixon, does not appear in the book, although many of his results are quoted.

Mechanical Mixing Machinery. By Leonard Carpenter. (Chemical Engineering Library, Second Series.) Pp. 138. (London: Ernest Benn, Ltd., 1925.) 6s. net.

ALTHOUGH this book deals with dry mixing, it overlaps in parts the volume on the same subject by Mr. Seymour in the same series. It is not altogether clear why the publishers should have thought it necessary to have had two volumes dealing with the same subject in the same series, but the two books will no doubt appeal to different classes of readers. The treatment is practical, and the book is well illustrated.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Ionisation Potential of Ionised Manganese.

IN his paper on the manganese spectrum (Phil. Trans. Roy. Soc., vol. 223 A, p. 127) Catalán gives some triplets and multiplets of the spectrum Mn II, and suggests identifications of some of them. I have recently made an attempt to estimate terms from some of these lines; two independent methods agree within the estimated limits of error, and it seems that it is possible thereby to estimate the ionisation potential with an error probably less than half a volt.

Catalán (*loc. cit.*) suggests that the enhanced triplet $\lambda\lambda$ 2576, 2594, 2606, and multiplet consisting of three triplets near $\lambda\lambda$ 2428, 2438, 2453 are the first principal and first diffuse triplets of Mn II. Back (*Zeit. f. Phys.*, vol. 15, pp. 238-40) has confirmed the first of these identifications by the Zeeman effect, and has shown that the terms belong to a septet system similar to the Cr I septets (for which see Gieseler and Grotian, *Zeit. f. Phys.*, vol. 22, p. 228), and he agrees with Catalán's identification of the diffuse multiplet.

Further, Catalán states that the lines $\lambda\lambda$ 2576, 2594, 2606 forming the first principal triplet are the most persistent of the enhanced lines of Mn, so they are probably the "ultimate lines" in Russell's sense (*Astrophys. Journ.*, vol. 61, p. 223), and if so, the septet $1s$ term corresponds to the normal state of the atom.

Now Hund (*Zeit. f. Phys.*, in press) has shown reason to believe that the distribution of electrons in the Cr and Mn⁺ atoms in their normal states is the same (5 electrons in $3s$ orbits and 1 in a $4s$ orbit, the inner n_k sub-groups being complete; this is the only case in the iron group in which the normal state of a neutral atom has the same distribution of electrons as the normal state of the ionised atom in the previous place in the periodic table), so the $1s$ terms of the Cr I and Mn II septets are really corresponding terms. Also for Cr I the zero of term value corresponds to the ionisation of the atom by removal of the $4s$ orbit, and if we take a corresponding zero for Mn II it seems likely that quantitative relations between the septet terms of the two spectra can validly be applied.

From the principal triplet alone it is possible to estimate term values in two ways. The quantum defect q for the n_k term, wave number ν , of an atom core charge C being defined by $\nu/R = C^2/(n - q)^2$ as usual, the two estimates are as follows:

(1) For Cr I septets, the s terms belong to a sequence of the Rydberg type, so they can be associated with different orbits of a single series electron, and the concept of a quantum defect is significant; and the first p term (Gieseler and Grotian's 4_2) looks like the first member of a Rydberg sequence. The difference of quantum defect between the first s term and the smallest member of the first p term is 0.46; judging from the behaviour of the similar difference in other spectra, it seems probable that its value for Mn II septets will lie between the limits 0.35 ± 0.02 . Using the first principal triplet above mentioned, this gives $1s(4_1) = 119,000 \pm 4000$.

(2) The triplet separation for the p term of Cr I fits the Landé formula (see *Zeit. f. Phys.*, vol. 25, p. 48) fairly well, so it may be expected that the relation between the separations for corresponding terms of Cr I and Mn II will be given by this formula. The

best way of applying it is through Δq , the difference of quantum defect q between the extreme members of a multiple term. The value of Δq for the 4_2 term of Cr I septets is 0.00584; for the corresponding term of Mn II it would be expected to be about 0.0061. The value of $\Delta\nu$ is known from the separation of the first principal triplet, so the value of the term can be calculated. It leads to a value $1s = 116,000$, the limits of error being estimated at ± 5000 .

The agreement of the two independent estimates, one from the position of a line of the triplet and the other from triplet separations, is most satisfactory; it seems likely that the $1s$ term of the Mn II septet system lies within the limits $118,000 \pm 3000$. The ionisation potential corresponding to the removal of the 4_1 electron is then 14.5 ± 0.4 volts.

It seems possible that similar methods may be of use in providing approximate values of terms of other spectra of ionised atoms, of which only a few lines are known, if suitable lines can be identified.

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The Future of the British Patent Office.

PATENT Law is a means to an end, and until the nature of the consideration which the patentee is to bring in in return for his monopoly has been clearly ascertained, it is idle to attempt to lay down what should or should not be the appropriate practice at the Patent Office. Now the object of British Patent Law has varied materially during the last three hundred years.

Coke, for example, is the chief authority for the construction of the Statute of Monopolies and this is his commentary: "The reason wherefore such a privilege is good in law, is because the inventor bringeth to and for the Commonwealth a new manufacture by his invention, cost and charges, and therefore it is reason that he should have a privilege for his reward" (Coke, 3 Inst. 181). Under the Stuart dynasty, the jurisdiction of letters patent was reserved to the Privy Council. This body administered the Statute of James in the sense of Coke's dictum. It insisted that the patentee should make good at the earliest opportunity and was always ready to revoke an unused patent in favour of a second applicant with better credentials; the latter became "the true and first inventor" under the Statute. About 1750, however, its jurisdiction was allowed to lapse, and patentees henceforward were compelled to seek their remedy in the Courts of Law. The latter, being without recent precedents to guide them, interpreted the contract in the letters patent in the light of the specification clause, and in 1778 it became established law that the patent specification was the price of the monopoly.

This doctrine held the field until 1883, when the needle of patent law again began to show signs of instability. The Patents Act of that year contained certain inoperative compulsory licensing clauses, which were afterwards strengthened, but in 1919 the needle once more veered round with a swing to the Statute of Monopolies—the Act of 1919 laying down that "patents for new inventions are granted not only to encourage invention but to secure that new inventions shall, as far as possible, be worked on a commercial scale in the United Kingdom without undue delay, and further providing that a patent shall not be invalidated by the prior sale of the inventors' product if a patent has been applied for within six months of such sale."

Hence there are two basic principles of patent law, (a) that patents are granted in consideration of the disclosure of inventions; (b) that they are granted for the institution of new industries.

Although both principles may fitly be recognised in a given system of patent law, they cannot be regarded as coequal. For the type of administration appropriate to (a) not only differs from, but also is even antagonistic to, that which would naturally be evolved under (b). Under (a) there must be a highly elaborated machinery for the investigation of novelty, with the result that patents will be granted with relatively narrow claims, and that the capitalist be able to buy inventions cheaply, for patents will possess little restraining power. An official search, no doubt, gives additional security, but the commercially valuable factor in a monopoly is its restraining power. Hence, as a general rule, when security is at its highest the other factor will be "little, or none at all."

Trustworthy evidence of the commercial value of patents is not readily obtainable—for it is against the interest of patent officials, agents and owners alike publicly to depreciate their own services or properties. The following communication, however, was sent to the present writer in 1923 from a well-known scientific writer in Washington. He writes: "I have been wondering for some time whether the world's patent offices are not about to break down under their own weight. Simple arithmetic shows that the possible permutations and combinations of known principles and kinds of matter are so numerous that their task is hopeless unless the definition of invention or originality is radically changed. The U.S. Patent Office is already in a badly demoralised state and far behind with its applications, and its patents have for some years been recognised as worthless in themselves, being essentially only tickets of admission to the courts of law." Corroborative evidence on this point will be found in my letter to NATURE, Nov. 11, 1922, p. 633. These are inside views of the effect of a universal search upon the selling value of patents.

The writer of the articles in NATURE of July 25 and August 1 proposes a search through the 1759 periodicals taken in the Patent Office Library. But what about the 24,028 registered in the recently published "World List of Scientific Periodicals"? His search is to be limited to suit the convenience and capacities of the examining staff. Section 41 (1) of the Patents and Designs Act 1907 established the principle that "what we don't know isn't knowledge" in order to round off the official 50-year search (see my letter as above). When I pointed this clause out to a legal authority, he said it was "damned nonsense"—but it is proposed in the articles referred to above to extend the principle.

The remedy is obvious. An administrative search for novelty has long been an economic absurdity. The direction in which reform should be sought, if the object of our patent law is to stimulate the growth of British industries, is in the relief of the patentee from the unduly high legal standard of novelty. Sir John Dewrance in his presidential address before the Institution of Mechanical Engineers in 1923 supports this contention. He writes: "It has always seemed to me to be unfair that documents should be evidence of anticipation: evidence should be of prior use." This relief can, of course, be granted to the patentee only upon proof of commercial working.

Hence official search for novelty should be restricted to secure that concurrent British patents are not granted with overlapping claims. With a simplified procedure and broader claims, which can be substantiated so soon as the patented process has been

reduced to practice, capital will once more flow into native industries.

Underlying the case presented in NATURE is the thesis that the public requires to be protected against the inventor. My case is that the inventor should be wooed and if possible won to come over and help us, and for this purpose I would make the law clear and consistent and the official practice cheap and expeditious.

E. WYNDHAM HULME

A Radio Method of Estimating the Height of the Conducting Layer.

IN a recent note we have outlined a method of estimating the height of the conducting layer by means of radio waves (M. A. Tuve and G. Breit, *Terr. Mag.*, vol. 30 (1925), pp. 15-16). Through the co-operation of the U.S. Naval Research Laboratory, Bellevue, Anacostia, D.C., we have obtained definite indications of reflections such as would take place from the layer and some estimates of its height. The method used consists in sending out interrupted high frequency wave-trains and observing the wave-form of the received signal. Each wave-train received manifests itself as a temporary rise in the detector current of the receiving set. One particular wave-train at the transmitter gives rise to two received wave-trains at the receiver if a single reflection takes place. One of these trains travels over the ground and the other by way of the layer. Thus the detector current is forced to rise at two different times by the same wave-train from the transmitter and an oscillogram of the detector current shows two humps generally of unequal size.

The transmitter was operated with a 500-cycle plate current supply so that a wave-train of 71.3 metres wave-length was emitted during a part of each positive half of the cycle. A succession of single humps is thus emitted. (We have made sure of this by observing the wave form at the same time at the transmitting and the receiving stations.) The receiving station was located 7 miles away from the transmitter in a general direction north, the Potomac River and the City of Washington being between the two stations. We have observed the received wave-form visually and photographically. Double and triple humps were observed on some days, though practically single humps were observed on others. Marked variations in the relative position and amplitude of the humps were observed during 10-minute observation periods. The retardation of the secondary humps with respect to the primary is of the order of 1/1700 second, which corresponds to a retardation over a length of roughly 110 miles and a distance of the layer of the order of 50 miles. Other humps correspond to 100 miles. The origin of triple humps is not clear. The possibilities of a wavy surface in the layer and successive reflections suggest themselves.

Experiments on other wave-lengths with different receivers and transmitters and in different locations seem valuable. We are hoping that such experiments will be performed by others as well as ourselves. Some experiments at 600 metres were performed in co-operation with the Radio Corporation of America, the distances between the two stations being about 150 and 100 miles. No definite indication of the presence of the layer was found in these cases.

G. BREIT,
M. A. TUVE.

Department of Terrestrial Magnetism,
Carnegie Institution of Washington,
Washington, D.C.

Science and Intellectual Freedom.

IN the issue of NATURE for July 18, p. 103, it is stated "Our sole object in taking up the subject of the prohibition of the teaching of evolution in certain States of the United States, and in inviting opinions upon this action from a number of leading authorities, has been to afford support to our colleagues fighting for scientific truth and progress against dogma and stagnation. We trust that the additional messages subjoined will give them the strength and courage they need to secure for them the position of intellectual freedom established in Great Britain many years ago, and existing unchallenged to-day."

It is possible to appreciate the good intentions of this patronage without admitting its need. Not intending to bite the hand that feeds us, I still venture to express a doubt as to whether the strength and courage of American men of science in their efforts to attain the intellectual freedom established in Great Britain will be greatly forwarded by the series of little articles published in NATURE and by the editorial comments.

Tennessee is the only State concerned, and it does not forbid the teaching of evolution, but only the teaching in tax-supported institutions of the derivation of man from a lower order of animals. The law is unfortunate, and is opposed by general public sentiment as well as by men of science. It should, however, be remembered that Tennessee also forbids the reading of the Bible in its public schools, it does not expect them to teach that the evolution of man is not true. The control of teaching by legislation is unwise, but no sensible teacher would want to lead children to question the religious convictions of their parents. Intellectual freedom is also interfered with when a premier prescribes that the children of a nation must study Latin, thus leaving no time for the study of science.

There is a larger proportion of "Fundamentalists" in every European nation than in the United States, and also a larger proportion of educated people who profess, without believing, the thirty-nine articles and other inherited creeds. Sir Joseph Larmor, the distinguished man of science who represented the University of Cambridge in Parliament, made it one of his chief pleas when he was first a candidate that he would support the maintenance of the control of the Church of England over tax-supported schools. It is not surprising if a majority of the rural population of Tennessee hold the creed that Mr Gladstone defended and that Lord Balfour exploits in more sophisticated fashion. They would scarcely follow the vagaries of Sir Oliver Lodge. The only scientific man here who manifests an interest in such things was sent to us from the University of Oxford. But perhaps it is undesirable to make international comparisons.

J. McKEEN CATTELL.

New York, July 30.

On the Spectra of Neon and Argon in the Extreme Ultra-violet.

At the April meeting of the American Physical Society (see *Physical Review*, 25, 886, 1925) we reported the existence of a very strong pair of lines in the spectrum of neon at $\lambda\lambda$ 743.78 and 735.95, together with some ten other lines, all combinations with a fundamental $1p$ term in this spectrum. We are glad to see that G. Hertz (*Die Naturwissenschaften*, May 29) has independently found the same strong pair, and that their position agrees satisfactorily with our measures and with that obtained by him from resonance potential observations.

It is perhaps worth while to note that the spectrum of argon contains a similar pair, at $\lambda\lambda$ 1048.28 and 1006.73 (± 0.2), together with a number of other lines of shorter wave-length, which are probably components of a like pattern. The strong pair fits exactly the resonance potential, 11.5 volts, found by Hertz. Another observed pair corresponds to its value of 14.0 volts. His third resonance potential, 13.0, seems not to correspond to any emission line, but the presence of unidentified impurity lines in our spectra makes it necessary to take further observations before giving final data.

The complete argon spectrum is probably like that of neon. The strong lines are therefore combinations of a fundamental $1p$ term with terms $1s_2$ and $1s_1$. The latter combine with other terms, as yet unknown, to produce several lines which are listed in tables of constant wave-number differences (cf. Kayser, "Handbuch," 7, p. 26, where two of the columns refer to such combinations). More observations on the spectrum of argon are, however, needed before the structure of the spectrum can be worked out.

In neon a curious fact has been noted. The line at λ 735 is normally stronger than that at λ 743, it is in fact the strongest line in the whole spectrum. When, however, a small quantity of neon is present as an impurity in helium, the relative intensities of the lines of this pair reverse, λ 735 becoming the weaker of the two. Our observations make it seem unlikely that this could be due to the presence of a sharp-edged absorption band in our helium. One would therefore suppose that collisions between atoms of neon and of helium render the peculiar atomic state yielding the line λ 735 less probable than is the case when the neon is alone. Argon as an impurity in neon shows no such effect.

THEODORE LYMAN
F. A. SAUNDERS

Jefferson Physical Laboratory,
Harvard University, July 25

Lunar Periodicity in Obelia.

IN Proc. Roy. Soc., vol. 95, 1923, Mr. H. M. Fox directed attention to a number of cases of "Lunar Periodicity in Reproduction" in marine organisms. To these may be added the hydroid *Obelia geniculata*. At first sight the periodicity is masked by the irregular breeding of colonies which are wave-worn or much eaten down by nudibranchs, but if attention is confined to healthy and perfect colonies, the lunar periodicity seems quite definite. During 1924 several colonies on the piers were located and watched, the best result was from a colony on Laminaria on Millport old pier, which was giving off medusæ during the ten-day periods beginning with the third week of the moon in July, August and September, and not at other times. Other colonies gave definite results in two consecutive months, but were then attacked by nudibranchs or lost.

More recently, twelve colonies at Keppel were examined on July 28 (first moon quarter)—none of them had gonothecæ, one colony had minute axillary buds beginning to form gonothecæ, on August 5 (full moon August 4)—of fifteen colonies examined, eight were worn, frayed or eaten, the remaining seven were healthy and ripe, including small colonies of only five or six branches, probably three weeks old.

Miss S. M. Marshall has confirmed these observations by noting occasional abundance of *Obelia* medusæ in the plankton about the third quarter of the moon. Colonies which have been much eaten by nudibranchs may, if abundant food be present,

recover rapidly and reproduce at any time, to which is probably due the fact that this case of lunar periodicity has escaped observation

RICHARD ELMHIRST.

Marine Biological Station,
Millport.

Magneton Numbers of Iron in some Complex Salts.

DR. L. C. JACKSON's letter in NATURE of June 27, p 981, points out the fact that an iron atom, known definitely to be ferrous, can have at least four distinct magnetic moments, namely, 26, 26.5, 27, and 27.5 when expressed in the magneton of Weiss. The purpose of this note is to present preliminary data tending to show that the magneton numbers for ferrous iron are not limited to 26-27.5, but can be 0 and 10 as well. Likewise, a ferric iron atom can have a magnetic moment corresponding to 0 and 10 magnetons in addition to the 29 magnetons usually obtained from measurements on simple paramagnetic salts. An example is included of an iron compound, the carbonyl, in which the iron certainly plays the part of a diamagnetic element

The data appear in the table below. The mass sus-

making use of Pascal's measurements on this salt in a dilute solution (*Ann. Chim. Phys.*, 1909, 16, 531, 8th ser.) Weiss's value, 10.41, becomes 10.2 when revised on account of the newer susceptibility, $k = -7.19 \times 10^{-7}$, assigned to the water used as a standard. 10.2 was therefore adopted as the correct magneton number for potassium ferricyanide, and all of the others were calculated by taking the magneton number to be proportional to the square root of the net susceptibility.

We note at once that the magneton numbers group themselves around ten and, very probably, zero. There is no doubt as to the ferric salts, provided that we accept the value of 10 magnetons for potassium ferricyanide. The fact that the ferrous diamagnetic salts give magneton numbers up to 1.5 may be due to the presence of small amounts of paramagnetic impurities or to uncertainties about the diamagnetic constants used in calculating the net susceptibilities. Both of these factors are important in dealing with diamagnetic substances. According to the table, the last ferrous salt, $\text{Na}_3\text{Fe}(\text{CN})_5\text{OH}_2 + \text{H}_2\text{O}$, does not yield 10 magnetons. 6.5 is the highest value yet observed. The salt is difficult to prepare and becomes more and more paramagnetic on repeated recrystallisation. At first it seemed to approach

Iron	Complex Salt (solid state).	Susceptibility, $\frac{K \times 10^7}{\text{gm}}$	Susceptibility, $\frac{K_m \times 10^7}{\text{gm. mol.}}$	Net Susceptibility of Iron $K_i \times 10^7$ gm. atom	Magneton Number		
					Observed	Probable Real Value.	
					Weiss	Weiss.	Bohr
Ferric	$\text{K}_3\text{Fe}(\text{CN})_6$	+90.0	+29610	+30800	10.2	10	2
	$\text{Na}_2\text{Fe}(\text{CN})_5\text{NH}_3 + \text{H}_2\text{O}$	+95.3	+25500	+26500	9.5	10	2
	$\text{Na}_2\text{Fe}(\text{CN})_5\text{NO}_2$	+87.3	+26300	+27170	9.6	10	2
	$\text{Na}_2\text{Fe}(\text{CN})_5\text{OH}_2 + \text{H}_2\text{O}$	+104	+27900	+28880	9.8	10	2
	$\text{Na}_2\text{Fe}(\text{CN})_5\text{NO} + 2\text{H}_2\text{O}$	-3.497	-1042	-43	—	0	0
Ferrous	$\text{K}_1\text{Fe}(\text{CN})_5 + 3\text{H}_2\text{O}$	-4.07	-1720	+54	0.43	0	0
	$\text{Na}_2\text{Fe}(\text{CN})_5\text{NH}_3 + 6\text{H}_2\text{O}$	-2.77	-1052	+680	1.5	0	0
	$\text{Na}_2\text{Fe}(\text{CN})_5\text{NO}_2 + \text{H}_2\text{O}$	-1.49	-508	+582	1.4	0	0
	$\text{Na}_2\text{Fe}(\text{CN})_5\text{SO}_2 + 2\text{H}_2\text{O}$	-3.31	-1380	+99	0.58	0	0
	$\text{Na}_2\text{Fe}(\text{CN})_5\text{OH}_2 + \text{H}_2\text{O}$	+41.2	+12000	+13070	6.6	10	2
—	$\text{Fe}(\text{CO})_5$ (liquid)	-3.84	-752	-540	—	—	—

ceptibilities for potassium ferricyanide, potassium ferrocyanide, and iron carbonyl are taken from a paper by Oxley (*Proc. Camb. Phil. Soc.*, 1910-12, 16, 102), whose values have been recalculated since the susceptibility, k , of the reference substance, water, is now considered to be -7.19×10^{-7} rather than -7.5×10^{-7} . The other complex salts are formed by the substitution of the radicals NH_3 , NO_2 , etc., for one of the CN groups in either the ferricyanide or the ferrocyanide of sodium. One of them is the well-known sodium nitroprusside. The other seven were prepared by Dr Baudisch of this Institute, who followed, in general, the methods described by Hofmann (*Annalen der Chemie*, 1900, 312, 1).

The net susceptibilities pertaining to the gram atom of iron were obtained by allowing for the diamagnetic moment due to the atoms other than iron. For this purpose use was made of the diamagnetic constants listed by Pascal (*Revue générale des Sciences*, July 15, 1923). Since my measurements were made on the salts in the solid state, the Weiss formula for the magneton number

$$N = \frac{\sqrt{3RTK_i}}{1123.5}$$

is not directly applicable. But Weiss (*Jour. d. Phys.*, 1911, 1, 965, 5th ser.) has already calculated that iron in potassium ferricyanide has 10.41 magnetons by

5 Weiss magnetons, or one of Bohr's, as a limit. Since it passed 5 magnetons its upper limit is now believed to be 10. At any rate the magneton number of the iron in this salt is known to be greater than 6.6.

Still more interesting than this grouping of magneton numbers about zero and ten is the appearance of two inversions. Iron in most of the ferric salts has 10 magnetons, but in at least one ferric salt it has none. Similarly, the ferrous salts usually contain no magnetons, but in one of them we find at least 6.6 and very probably 10. We see then that the magnetic moment of iron is extremely variable, and that it is not uniquely defined by a statement of its valence.

Gerlach (*Ann. der Phys.*, 1925, 76, 163) has recently observed that iron in the vapour state has no magnetic moment. This suggests that its paramagnetic properties in a salt, either solid or dissolved, are due entirely to the distortion of its electron system by the neighbouring atoms with which it is combined, or by the water molecules surrounding the ion. Altogether there seem to be at least seven principal states in which the iron may exist on account of these external forces of a chemical nature. Putting it in another way, there are at least seven main configurations of the electron system known to us as the iron atom. They are ferric iron, giving 0, 10, and 29 magnetons, ferrous iron giving

o, 10, and the group of 26 to 27.5 magnetons; and then there is the iron which is nearly as diamagnetic as Pascal (*Revue générale des Sciences*, July 15, 1923) has found bismuth to be in its compounds.

LARS A. WELO.

Rockefeller Institute for Medical Research,
New York, July 23

MR. WELO's interesting letter directs attention to the fact that the iron atoms in various complex cyanides possess quite different magnetic properties from the iron atoms in simple ferrous or ferric salts. The existence of iron atoms which are either paramagnetic, but have a moment considerably smaller than that found in the simple salts, or even diamagnetic (zero magnetic moment) finds a parallel in the observation of Pascal that oxygen may function in organic compounds as a paramagnetic element with the "usual" moment, as paramagnetic with a lesser moment and also as diamagnetic.

The susceptibilities of a large number of complex co-ordination compounds of cobalt and nickel are known. It would be of considerable interest to carry out similar calculations to Mr. Welo's with these data also. Cobalt and nickel atoms with zero magnetic moment may be expected, but the interesting point would be the determination whether these elements exist in modifications analogous to Mr. Welo's iron with 10 magnetons.

It may be of interest to mention the non-magnetic films of nickel which have recently been described. Their existence has been ascribed elsewhere to a rearrangement in the electron configuration similar to that suggested by me in the letter referred to by Mr. Welo. By this rearrangement the electron configuration of the nickel atom becomes completely symmetrical and hence the atom possesses no magnetic moment.

A further study of data such as are given by Mr. Welo and those derived from the simple salts of the magnetic elements is likely to be of considerable interest in giving some evidence of the deformations or rearrangements of the electron orbits of an atom in a solid compound. The magnetic properties of the free undeformed atom may be inferred from spectroscopic data.

Two further points may be mentioned in connexion with Mr. Welo's letter. First, his method of calculation of the magneton numbers implicitly assumes that the various substances obey Curie's law $KT=C$. In general, however, paramagnetic substances obey the more general law, $K(T+\Delta)=C$, so that a single measurement at one temperature is not sufficient for the determination of the Curie constant C , from which the magneton numbers are calculated according to Weiss. Mr. Welo's numbers may, therefore, need a correction on this account. Further, it is scarcely permissible to calculate the Bohr magneton numbers merely by dividing the corresponding Weiss numbers by 5 since, though the Bohr magneton is essentially a quantum unit, no account is then taken of the spatial quantisation factor.

Secondly, it seems that there is a slight misunderstanding of the purpose of my letter already referred to. It is perfectly reasonable to expect that iron atoms in quite different modes of combination should possess different magnetic properties, but in the letter attention was directed to the fact that iron atoms in ferrous compounds may exist in different magnetic states in one and the same compound. Thus the four values of the magneton number there mentioned were obtained from observations on ferrous ammonium sulphate.

L. C. JACKSON.

The Band Spectra associated with Carbon.

HAVING read with great interest the two communications by Prof. Raymond T. Birge, published in *NATURE* of August 1, p. 170, and August 8, p. 207, I should like to direct attention to the fact that I gave in 1924 the description and wave-lengths of the band spectrum described a year later by Dr. R. C. Johnson as "A New Band System" in *Proc. Roy. Soc. A*, 108, 349, June 1925, and called "the new Johnson group" by Prof. Birge (*NATURE*, August 8, p. 207).

My first publication concerning these new bands appeared in *Comptes rendus*, 178, May 5, 1924, p. 1525, under the heading "Sur les spectres de la décharge thermionique dans l'oxyde de carbone. Nouveau spectre de bandes" (italics mine here). It was also published with a photographic reproduction of the bands in *L'Astronomie*, 38, Nov. 1924, 444, Fig. 236.

The thermoelectronic bulb filled with pure carbon monoxide at a pressure of about half a millimetre gives with intensity only the three double-headed bands at λ 4236, 3978, 3730, while the helium mixture of Dr. Johnson gives three additional bands. So far as I can judge with such a limited number of bands, it appears that the distribution of the intensities seems a high-temperature distribution with thermoelectronic bombardment, while it would be a low-temperature distribution in a helium mixture. Prof. Birge has rightly made the same remark for the comet-tail bands (*NATURE*, August 1, p. 171).

Since the publication of my above-mentioned papers, I have obtained the three bands with a great dispersion, and I will give later the analysis of their fine structure.

F. BALDET.

Observatoire de Meudon, August 12.

The Transport of Organic Foodstuffs in Plants.

FROM the ringing experiments of early times, it has reasonably been inferred that foodstuffs are translocated downwards by the phloem. But to complete the evidence it would be necessary to prove directly that the tissues external to the wood can translocate foodstuffs by themselves. Adequate experimental evidence for this has never been produced, and recently it has been maintained that downwards as well as upwards the foodstuffs must be translocated by the wood. (Dixon, H. H., and Ball, N. G., *NATURE*, February 23, 1922, vol. 109, p. 236.)

Evidence for translocation by the rind I have, however, now been able to obtain by rooting shoots of *Salix fragilis* in tap-water, and peeling off from below upwards strips of rind from 4 to 8 cm long, each carrying a root. The strips remained connected with the shoots above. The roots on these strips grew at rates up to a centimetre a day, and nearly as fast as similar roots on intact parts of the same shoots. They continued to grow indefinitely. The foodstuffs for their growth must have been translocated from the shoot, for roots on short, completely isolated strips of rind grew only for a few millimetres and then stopped, showing that the local supply was insufficient. Since new wood did not begin to be regenerated for from four to eight days, the foodstuffs must have been translocated by the rind alone.

It should be mentioned that before the roots on the strips of rind could be got to grow, it was found necessary either to prevent the water surrounding the roots from touching the inner surfaces of the strips, or to keep this water sterile with one part in 120,000 of thymol.

It is hoped to continue the experiments next spring.

R. SNOW.

Magdalen College, Oxford.

The New Ideas in Meteorology.¹

By Dr. G. C. SIMPSON, F.R.S.

THE first quarter of the twentieth century will always be remarkable for the great advances made in science. In our own particular branch the advance has probably been the most startling and has appealed very strongly to the popular imagination. In mathematics we have had a little-known and even less-understood branch of pure mathematics applied to physical problems with results which have revolutionised our whole conception of the universe in which we live. In astronomy we have had described to us an evolution of the heavenly bodies as real and as dominating as the evolution which the previous century revealed in the animal kingdom. In physics the progress made has been most remarkable. At the beginning of the century, it is true, we had been introduced to the electron, to Röntgen rays, and to radio-activity; Planck was also writing on the laws of radiation; but no one realised the powerful tools which these phenomena were going to put into the hands of physicists. These tools have, however, been used, and not least by our own countrymen, to dig deep into Nature's secrets, even into the atom itself, so that now we are able to visualise the component parts of an atom, which itself is a structure far removed from our powers of perception.

Meteorology, although a child of applied mathematics and physics, has scarcely been touched by the epoch-making discoveries in the house of its parents. The quantum has found no place in our theories of the mechanism of the atmosphere, a knowledge of the structure of the atom has not helped us to understand the physics of the air as we deal with it in meteorology; the relationship between mass and charge, the invariability of the velocity of light, four-dimensional space and all the other new conceptions which have been responsible for the advance of physics, have been of no help to meteorologists in their especial branch of science.

The whole attention of physicists has been so dominated by these new ideas, and the vistas of unexplored country which they have opened out are so vast, that it is no wonder that physicists have had no interest in a domain in which their new tools could not be employed. The consequence has been that meteorology has had little help from physicists and mathematicians as such, and has had to depend, at least in Britain, on the relatively small band of meteorologists in Government employ. Let me say, however, that we are grateful for the help which we have received from physicists, especially from those who were brought into contact with meteorology during the War. In spite of the fact that meteorology has not been able to make use of the recent discoveries in pure physics, there has been in the last twenty-five years as fundamental a revolution in our ideas of the atmosphere as has taken place in our ideas of electricity and matter. Unless I am very much mistaken, however, these fundamental changes in our conception of the atmosphere, both as a whole and in its parts, are

little known outside the small band of professional meteorologists. I therefore welcome this opportunity of bringing them before the members of Section A of the British Association.

THE THERMAL STRATIFICATION OF THE ATMOSPHERE.

The fact that the temperature of the air decreases as we ascend in the atmosphere has been known from time immemorial, but our real knowledge of the temperature of the free air dates only from 1898, when Teisserenc de Bort introduced his *ballons-sondes*, which carried self-recording instruments to heights in the atmosphere up to that time never attained and from which no information was then available.

The initial success of Teisserenc de Bort in his epoch-making discovery of the stratosphere attracted great attention to his investigations. His methods were introduced into other countries, and an intense investigation of the upper atmosphere, with an International Commission to guide and encourage it, was inaugurated. In Britain, Mr. W. H. Dines did Trojan service in the cause, and his observations and deductions are outstanding in the mass of data accumulated in many parts of the world. Naturally the conditions over Europe and North America were investigated in the greatest detail, but every opportunity has been taken by meteorologists to obtain upper-air data from all parts of the world. In addition to the regular observations undertaken in most countries having an organised meteorological service, expeditions have gone out specially to investigate the upper atmosphere over the oceans and over tropical Africa, and nearly all recent polar expeditions have included this investigation amongst their scientific activities.

There are, of course, large tracts of the earth's surface above which no observations have yet been made, but some, if only a few, observations have been made in all meteorologically important areas, including both polar regions. It is on the results of these observations that we base our conception of the thermal structure of the atmosphere, and meteorologists have attempted from them to generalise the conditions in all parts of the world. The most important generalisation of this kind has been made by Sir Napier Shaw and published in the form of diagrams in his book, "The Air and its Ways."

Probably every one here is familiar with the main results of these investigations. The atmosphere, which itself is an extremely thin film of air, is composed of two shells surrounding the earth. In the lower of these shells, called the troposphere, the temperature decreases as one rises in the atmosphere, and the air is warmer over the equator than over the poles at corresponding heights. In the upper shell, called the stratosphere, the temperature conditions are entirely different. There is little or no change in temperature with height, and the horizontal change of temperature is reversed, the temperature at the same height in the stratosphere decreasing as one passes from the poles to the equator. At the earth's surface the mean

¹ From the presidential address delivered at Southampton on August 28, before Section A (Mathematical and Physical Science) of the British Association.

annual temperature near the equator is 27°C . and at the poles -23°C .; i.e. the equator is 50°C warmer than the poles. At twenty kilometres above the surface the temperature over the equator is -80°C , and over the poles -30°C .; that is, the temperature difference between the equator and the poles is the same in amount at the surface and at a height of twenty kilometres, but in the former case it is the equator which is the warmer, while in the latter it is the polar regions—a truly remarkable reversal.

The surface of separation between the two shells, called by Sir Napier Shaw the "tropopause," is extremely sharp. There is no region of transition. The stratosphere sits on the troposphere like a layer of oil on a layer of water. The boundary is, however, not horizontal, and therefore not exactly concentric with the earth's surface, being higher at the equator than at the pole. In other words, the lower atmospheric shell, the troposphere, is thicker at the equator than at the poles. At the equator it is nearly twenty kilometres thick, while at the poles it thins down to a layer less than six kilometres thick in the summer and less than four in the winter.

I have already said that in the troposphere the temperature decreases as one ascends. The magnitude of this decrease varies from place to place and from time to time, but one remarkable result has come out of the investigation, and that is that the average decrease is practically the same in all parts of the world. Near the ground the conditions are complicated; here the rate of decrease is largely affected by such factors as the kind of surface, whether land or water, the time of day and the time of year. If we omit for this reason the two lower kilometres of the atmosphere, we are able to state that the rate of decrease of temperature with height, to which I shall refer as the "lapse rate," is the same in all parts of the world, from the equator to the poles. The lapse rate is not the same at all heights, but increases regularly as one ascends. Between two and four kilometres above sea-level the rate of decrease is 5.6°C for each kilometre of ascent; the rate is greater at greater heights, until towards the top of the troposphere, say between six and eight kilometres, the rate is 7.1°C per kilometre.

The importance of these results lies in the bearing they have on the possibility of vertical motion in the atmosphere. Whether air will rise or fall as the result of differences of temperature depends not only on an initial difference of temperature but also on the lapse rate in the surrounding atmosphere. When dry air rises its temperature falls on account of adiabatic expansion 10°C . for each kilometre of ascent. From the observed values of the lapse rate given above, it will be seen that if a mass of air is as much as 10°C . warmer than its surroundings it cannot rise much more than two kilometres before it has no buoyancy left. The question of ascending and descending air is, however, very complicated on account of the condensation of the water vapour carried with it. The vertical motion of the atmosphere cannot be determined simply from consideration of the lapse rate of temperature in the atmosphere. We have also to take into account the pressure and vapour content of the moving air. This can best be done by considerations of entropy.

Sir Napier Shaw has prepared diagrams showing the entropy throughout the normal atmosphere. These show surfaces of constant entropy which are nearly horizontal, but they slope upwards from the equator to the poles, especially in the lower layers. If these surfaces could be made visible, we should see a series of layers lying one above the other like the strata in a geological specimen of stratified rock.

In all movements of the air in which heat is neither added nor extracted—for example, by condensation or radiation—it must travel along an isentropic surface. Even if condensation takes place, the amount of heat added is usually so small that the air can only move to a neighbouring isentropic surface slightly higher in the atmosphere. These isentropic surfaces act like physical restraints to the air, tending to prevent its moving in any but an almost horizontal direction. The effect is almost exactly as though the atmosphere were definitely stratified in nearly horizontal planes, so that all motion of the air must take place along the strata in which it started.

This is what I mean by the thermal stratification of the atmosphere, and it is a new idea in meteorology, for it rules out ascending and descending currents as a direct consequence of the normal temperature distribution in the atmosphere. That ascending currents do occur and play a large part in atmospheric processes is, however, a matter of both observation and inference. We can actually see them taking place whenever we observe well-developed cumulus clouds, and we infer them from the large amounts of precipitation which we measure, for appreciable precipitation can only be accounted for on the assumption that air is rising in the atmosphere and cooling by adiabatic expansion. These ascending currents are possible in the stratified atmosphere only if the air taking part in them receives sufficient heat on its ascent to raise its entropy at least to that of the surrounding atmosphere at each level. Heat is supplied by condensation of water vapour, but normally air does not hold sufficient water vapour, even when saturated, to supply the requisite heat, and so cannot pierce the normal stratification. It sometimes happens, however, that the stratification is less pronounced than at other times. The greater the lapse rate the less the stratification, and by increasing the lapse rate sufficiently the stratification can be reduced to such an extent that there is sufficient water vapour to supply the heat required. When this occurs the atmosphere becomes unstable to saturated air and ascending currents take place, generally with considerable violence.

Such conditions give rise to thunder-storms, which occur, as is well known, only when the lapse rate has been abnormally increased, generally by the heating of the surface layers faster than the layers higher in the atmosphere. Also in equatorial regions over the ocean, where the air is very hot and also very humid, there may be sufficient water vapour in the air for it to rise through the normal stratification. This is the origin of the squalls and heavy rain in the Doldrums. From this it will be seen that the ascent of air through its environment is not a normal phenomenon, but does occasionally occur in special circumstances.

The descent of air is an entirely different matter, for there is no process which extracts heat from a

descending current equivalent to the process of condensation which supplies heat to an ascending current. Yet air cannot descend through the stratification without the necessary heat being extracted. On the other hand, we do know that air descends, for the air which goes up in the ascending currents, or rather an equivalent amount, must come down somewhere. The solution of the problem is that air practically never descends through its environment, but comes down by the gradual subsidence of a whole column. This is generally brought about by the air at the bottom of the column spreading under the surrounding air and so lowering the air above in a way to be described in greater detail later.

If now we consider the undisturbed atmosphere in different parts of the world, we find that each has its own stratification, which is mainly determined by the local radiation. At the equator the stratification is not so close as at the poles, and equivalent strata are higher in the atmosphere the farther we move from the equator. If a large mass of air is transported as a whole without gain or loss of heat, no change in entropy occurs, and therefore it retains its original stratification. It is therefore clear that if masses of polar and tropical air are brought together the strata will not fit. The process is something like removing two geological specimens from different parts of a stratified rock and then placing them side by side. We can recognise the surface where the two masses meet by the discontinuity in the strata; in geology such a surface of discontinuity is called a fault. We shall consider later the consequence of bringing together masses of air of different origin in this way, and it will be shown that they interact like separate fluids, but throughout the resulting motion they retain their stratification, although this stratification becomes modified and distorted.

This idea of the stratification of the atmosphere which has caused us to recognise that ascending and descending currents are relatively rare occurrences raises new problems as to how the solar energy is converted into the kinetic energy of winds. This leads me to the second subject of this address.

THE MECHANISM OF THE ATMOSPHERIC HEAT ENGINE.

Brunt has calculated from considerations of wind and atmospheric friction that 25×10^{11} kilowatts of energy are required to maintain the motion of the atmosphere. It is generally agreed that this energy is derived from the solar radiation which falls on the earth, the atmosphere itself acting as a gigantic heat engine to convert the solar energy into the kinetic energy of the winds. How the atmospheric heat engine works is the problem which we are now to discuss.

Until quite recently this problem seemed to present no difficulty. All atmospheric motion was referred in one form or another to the ascent of warm air through cold air and the descent of cold air through warm air. The so-called general circulation of the atmosphere was considered to be the direct consequence of the ascent of warm air at the equator and the descent of cold air at the poles, there being a permanent circulation from the equator to the poles in the upper atmosphere, with a return flow in the surface or middle

layers. Similarly cyclones were considered to form in regions where the air is warmer than the surrounding air, with a consequent upward motion of the warm air through its colder environment. The anticyclone, on the other hand, was considered to be a region of cold descending air. Thus cyclone and anticyclone were regions of ascent of warm and descent of cold air respectively.

I have already shown, however, that the thermal stratification of the atmosphere, except in the Doldrums and occasionally in other regions, is prohibitive of such ascending and descending currents. Further observations have shown that there is no direct flow of air from the equator to the poles in the upper atmosphere, and measurements of temperature in cyclones and anticyclones have shown that the former are not warm and the latter are not cold.

Although the old ideas were wrong in detail they were, of course, right in principle, for the potential energy inherent in masses of air at different temperatures must be the origin of the kinetic energy of the winds, the difference in temperature between the equator and the poles being responsible for the general circulation of the atmosphere, and the difference in temperature between neighbouring masses of air for the energy of cyclones and anticyclones. The only question is, how does the transfer from potential to kinetic energy take place?

The solution of the problem was given by Margules in a series of papers, commencing in 1903, in which he investigated the energy developed in storms. Margules' work leads to an entirely new idea as to the method by which solar energy is converted into the kinetic energy of atmospheric motion. Instead of warm air rising vertically like the warm gases in a chimney, drawing air in at the bottom and delivering it at the top, we see two bodies of air, one warm and the other cold, brought side by side, then the cold mass slowly subsiding and pushing its way as a wedge of cold air under the warm air, which is partly raised and partly drawn in above to replace the cold subsiding air. In the process the centre of gravity of the whole moving mass is gradually lowered, so providing the energy for the motion which we recognise as winds.

The essential difference between the new and the old idea is that the two masses of air, in which the difference of temperature is the cause of the motion, never mix. We start with the two bodies of air side by side, with a surface of sharp discontinuity between them. In each body there is a different stratification of isentropic surfaces. In the warm body of air the corresponding isentropic layers are all lower than in the cold body of air. As the cold mass subsides its isentropic layers are lowered, while as the warm air is raised its isentropic layers are raised with it; but the surface of discontinuity between them, which I have previously likened to a geological fault, is a sliding surface, and no air crosses it. The sliding motion does not cease until either the corresponding isentropic layers on the two sides have joined up across the surface, which then ceases to be a surface of discontinuity, or until all the warm air has been raised above the cold air and the surface of discontinuity becomes a horizontal plane. The two masses are then in equilibrium without any mixing having taken place.

SURFACES OF DISCONTINUITY.

The process which I have just described would take place very rapidly on a stationary earth, and in a short time the surface of discontinuity would disappear in the manner described or appear as a horizontal surface with all the cold air underneath and all the warm air above. But in the atmosphere we find inclined surfaces of discontinuity persisting for days together, and others which are apparently permanent. This arises from the effect of the rotation of the earth, which we have so far neglected, but which introduces new forces when air is in motion.

A mathematical investigation of the conditions governing the air motion at surfaces of discontinuity has shown that, on a rotating earth, the tendency of cold air to pass under warm air can be completely counterbalanced by forces due to the earth's rotation if the air on the two sides of the surface has suitable relative velocities.

We owe the mathematical investigation of this problem chiefly to Helmholtz, Margules, V. Bjerknes, and Exner.

Two bodies of air at different temperatures will remain in equilibrium side by side if suitable motion parallel to the boundary is given to the air on each side. The angle which the surface of discontinuity makes with the horizontal depends on three factors, namely, the latitude and the difference in temperature and relative motion of the warm and cold currents. Given steady motion, these three factors adjust themselves in a perfectly definite way, with the cold air lying as a rule in the acute angle which the boundary makes with the horizon.

V. Bjerknes considers that there are three great permanent surfaces of discontinuity of this kind in the atmosphere, and that the slope of the surface in each is in accordance with the discontinuities of the wind and density observed on the two sides. Taking these in turn, the first is the great surface of discontinuity between the troposphere and the stratosphere. The second surface of discontinuity is between the trade winds and the anti-trade winds above them. Bjerknes' third surface of discontinuity, which has received the name of the "polar front," is a very important one in modern meteorological theory. On the whole there is very little air motion in polar regions, and the cap of air over each pole is losing heat by radiation and so tending to subside and flow away from the pole. As the air from the polar cap flows radially outwards it is deflected to the west on account of the earth's rotation. On the other hand, in middle latitudes, from near latitude 30° to the polar circle, the air is moving in an almost unbroken stream from west to east. Relative to the air in the polar cap this air is very warm. We therefore have a cold cap of westerly-moving air embedded in a warmer mass of air moving towards the east, and between the two there must be a pronounced surface of discontinuity. In such conditions the surface should slope upwards toward the pole. V. Bjerknes considers that there are such surfaces of discontinuity associated with each pole and that they are very stable. These "polar fronts" play a large part, as we shall see later, in Bjerknes' theory of the formation of cyclones.

But these are not the only surfaces of discontinuity

which play a very real part in the physics of the atmosphere. While the three surfaces just described are of a more or less permanent nature, we now recognise a constant succession of temporary surfaces of discontinuity which form and pass away in our own latitudes. Their presence is revealed in many ways. On the synoptic charts lines can be drawn which divide regions in which the conditions at the surface as regards temperature, humidity, and wind velocities are entirely different. These lines are simply the intersection at the earth's surface of the surface of discontinuity between two bodies of air.

THE ORIGIN AND STRUCTURE OF CYCLONES.

The old idea of a cyclone was tersely expressed by Sir Oliver Lodge, in a letter to the *Times* last year, as follows: "A cylindrical vortex with its axis nearly vertical, rolling along at a rate conjecturally dependent partly on the tilt, and with an axial uprush of air to fill up a central depression, which depression, nevertheless, was maintained and might be intensified by the whirl, the energy being derived from the condensation of vapour." If this were the true mechanism of a cyclone we should expect to find considerable symmetry around the axis. The air would move in a continuous stream circulating around the centre but always approaching it; in other words, the stream lines would be continuous spirals. There would also be little difference of temperature in the different parts of the cyclone, for the same air current would pass successively through all parts. In reality the conditions are entirely different. When stream lines are drawn by the aid of the wind arrows on synoptic charts it is impossible to connect them so that they circulate all round the depression; we find, on the contrary, that they are discontinuous, the stream lines in certain parts meeting the stream lines in other parts almost at right angles. Also we find large discontinuities in the temperature, each set of stream lines having its own temperature. Further, we find that the areas of rainfall are not confined to the central regions, but are broad bands radiating from the centre like spokes in a wheel, showing that the ascending air is not taking place mainly in the central region.

As the result of recent work we now recognise a structure in a cyclone which was unknown a few years ago. We owe this new knowledge largely to the work of J. Bjerknes and his assistants in the Bergen Geophysical Institute.

We are being forced more and more to recognise in cyclonic depressions the meeting-place of polar and equatorial air. Each body of air is stable to vertical currents within itself, but where the two masses meet, readjustment is necessary; the surfaces of discontinuity tend to set themselves at the angle necessary for stability under the existing condition of velocity and temperature. This involves the bodily raising of the warm air over the cold air and a general sinking and spreading out of the cold air. The energy for the process is derived from the conversion of potential energy into kinetic energy, as the centre of gravity of the air as a whole is slowly lowered during the readjustment of the air masses. The energy derived from the condensation of water vapour is a very insignificant part of the energy developed in a cyclonic depression.

It must be admitted that we are still far from a complete understanding of the mechanism of cyclonic depression; on the other hand, we now know some features which are common to all depressions, and we have a much clearer idea of the source of the energy and the conditions necessary to their production. We have to imagine that in polar and tropical regions the air is relatively stagnant, and so has an opportunity to reach the state of thermal equilibrium appropriate to those regions. As already stated, the atmosphere is only a thin film, and we picture large areas or slabs of this film breaking away from their proper locality and moving into middle latitudes. Apparently the detached films move as a whole, at least to a considerable distance within the stratosphere. When two such portions of the atmospheric film come into juxtaposition they are not in equilibrium relative to one another, and readjustment must take place. The surface of contact remains more or less intact, but the cold air tends to sink and undercut the warm air, while the warm air slides up the surface of discontinuity. The whole motion takes place on the revolving surface of the earth, and the forces called into play by this revolution result in the air movement taking place in what appears to be a great vortex. The energy of the winds is derived mainly from the readjustment of the centre of gravity of the air mass considered as a whole, although the latent heat of condensation provides some additional energy by supplying heat to the warmer air as it ascends the slope of the surface of discontinuity. It will be admitted, I think, that this is a radically new idea regarding the mechanism of a cyclone.

All that I have said so far refers to the cyclonic depressions of middle latitudes. As to whether the mechanism of tropical cyclones is the same or whether we have here something more of the nature of the process described by Sir Oliver Lodge, meteorologists are not yet agreed. We need more observations, especially of the conditions in the upper air over tropical cyclones, before this question can be decided. At present we must leave it an open question.

These new ideas have had a far-reaching effect on the practical applications of meteorology, especially in the domain of weather forecasting. The old method of weather forecasting was mainly empirical and based on the work of Abercrombie. Abercrombie had sketched the distribution of weather about centres of high and low pressures, and forecasting was based on the determination of the movement of these pressure distributions when they appeared on the weather chart, the assumption being made that as the pressure system passed over a place the normal sequence of weather would be experienced.

Now the forecaster has much more knowledge of what I may call the anatomy of a depression. The pressure distribution is of course still the main factor, but the forecaster searches his chart for indications of the surfaces of discontinuity, and examines the characteristics of the air masses to see whether they are of polar or equatorial origin. In this way he is able to determine the structure of the cyclone and whether it is developing or dying. Having determined where the surfaces of discontinuity are situated, he is able to say where rain may be expected, and he knows what weather changes will accompany the passage of each surface of discontinuity as it moves over the surface of the land. He is aided in this by observations taken in the upper atmosphere by means of pilot balloons and aeroplanes fitted out with meteorological instruments.

This has all resulted in greater confidence in the forecasts made, a confidence which is frequently justified by remarkably accurate forecasts. Unfortunately, the processes which take place in the atmosphere are extremely complicated, and perfect forecasts are still far from being attained. The progress made, however, is very encouraging, and, what is still more important, the paths along which further investigation must be made are clearly defined. Many more observations of the upper air are necessary, many more theoretical investigations have to be made in the quiet of the study, and there is room for many more experiments in the laboratory.

Dispersal of Butterflies and other Insects.

By E. P. FELT, State Entomologist of New York.

A 2000-mile air trip appears almost impossible for an ordinary butterfly. It is still something of a feat for an airplane. Many insects are perfectly at home in the air, fly freely here and there, and are usually believed to flit from flower to flower or from one near-by locality to another. Rarely do we think of their travelling considerable distances, and under ordinary conditions it is very difficult, if not well-nigh impossible, to establish the fact that long trips may be made by individual insects. There is a romance about these journeys as well as a practical aspect. The facts are not difficult to understand, and it should be comparatively easy for readers to arrive at satisfactory conclusions.

The "Monarch" butterfly (*Danais plexippus* L.) is one of the commonest and most noteworthy insect travellers. Its large size and tawny colour with black and white markings make it comparatively easy to

recognise even at some distance. This is the very common "milk-weed" butterfly of the northern United States and southern Canada, the insect which occasionally attracts notice because of the immense swarms which appear in early autumn, apparently southward bound. The butterfly, although so common in the north temperate latitudes, is unable to survive our winters north of the sub-tropical portions of the Southern States. Consequently, the annual reappearance of this insect proves a considerable northward movement each year, though it does not establish the fact that the entire journey from Florida nearly to the Arctic Circle is necessarily accomplished by individuals. It may be the successive efforts of several generations working northward with the advance of warm weather.

A similar northward flight is known for the cosmopolitan "Painted Lady" (*Pyrameis cardui* L.) in

Europe. The butterflies cross the Mediterranean Sea, and in the opinion of Mr. C. B. Williams originate south of the north coast of Africa, since they have been seen entering Algeria from the south and have been observed crossing the Nile Valley near Cairo in thousands, coming from the south-eastern desert. He believes that all Europe north of a line through the middle of France and South Germany or Switzerland depends entirely for its Painted Lady butterflies upon African areas south of the great desert, some finding their way to northern Scotland, Scandinavia, the Shetland and Faeroe Islands, and even distant Iceland.

The above cannot explain the presence of the Monarch butterfly in the Hawaiian Islands, areas 2000 miles from the American continents, where the insect was not known prior to the establishment of its food-plant a milkweed (*Asclepias curassavica* L.), in the islands about 1850. At one time it was thought that this butterfly may have made its way to the mid-Pacific with the aid of shipping, in spite of the fact that the habits of the insect are such as to make it improbable that it could be carried with its food-plant in its early stages, or be content to remain upon a ship during an entire voyage. Furthermore, shortly thereafter this butterfly became generally established in a number of other Pacific islands, and if commercial agencies were the carriers, they certainly were very accommodating. The observations of Commander Walker of the British Navy indicate the habitual presence of these butterflies at sea among the Pacific islands and many miles from land.¹

The above facts are not conclusive as to the ability of the Monarch butterfly to negotiate safely a 2000-mile journey over the Pacific Ocean, and yet they are very suggestive. There is a remote possibility that some unusually favourable condition may have made it possible for this insect to establish itself in the mid-Pacific. It happens, however, that three other large butterflies, the Red Admiral (*Pyraus alalanta* L.), the Painted Lady (*P. cardui* L.), and the Painted Beauty (*P. virginensis* Drury), have been found in the Hawaiian Islands during recent years, and in the case of two at least not until the native food-plants had been introduced. An unusual condition may explain the presence of one insect, but can scarcely be considered as the reason for the establishment of three others many years later, particularly when in all cases the lack of a suitable food-plant appears to have been the determining factor.

The 2000-mile aerial trip of the four butterflies mentioned above still seems rather incredible, and with this in mind we would turn for a moment to the dragon-flies of the Hawaiian Islands. At least two of the larger species are widely distributed in America, and were not found in the Hawaiian Islands until comparatively recent years. Apparently the extensive cultivation of rice and taro has resulted in great expanses of fresh water in which these dragon-flies could breed, and it seems entirely reasonable to think that if the butterflies travelled on the wings of the wind, the same might be true of these dragon-flies, and that the determining factor in each case was the prevalence of conditions favourable to the propagation of the species.

Dragon-flies are well known as strong flyers, and there is at least one record of these insects appearing in large numbers in the Indian Ocean about 900 miles west of Australia and nearly 300 miles from the relatively insignificant Cocos-Keeling Islands, tiny land areas where dragon-flies are unable to maintain themselves according to Prof. F. Wood-Jones, and yet frequently visited by considerable flights of these insects, coming with northern winds, presumably from distant Sumatra.

It certainly begins to look as though we must accept the 2000-mile air trip as the most reasonable explanation of the occurrence of these insects in the somewhat isolated Hawaiian Islands, and admit that nearly half that distance is repeatedly travelled by insects journeying over the Indian Ocean. It is perhaps assumed that this is possible only in the case of strong flying insects, such as the larger butterflies and the more powerful dragon-flies. This latter does not necessarily follow. The terrible eruption of Krakatoa in August 1883 devastated that entire group of islands, they being overlaid by hot ashes approximately 90 to 180 feet thick, making it very improbable that anything living could escape, yet twenty years later some 64 species of insects were found upon this seldom visited group, and investigations by Dr. Dammerman, published in 1922, show that certain extremely small flying insects, such as thrips, were represented upon the island by some ten species. He estimates that 80 per cent. of the animals on these islands are winged. Furthermore, the work of naturalists at such outlying points as the Kentish Knock Lighthouse, some twenty-one miles from the nearest points of land, resulted in capturing, among a number of other insects, a delicate plume-moth with somewhat the consistency of a bit of thistledown. Similarly, studies at the Rebecca Shoal Light Station, itself entirely submerged and 12 miles east of the Dry Tortugas, showed the presence of such comparatively inefficient flyers as a lace-winged fly, a damsel-fly or small dragon-fly, and fragile gnats. In other words, insects with supposedly very weak powers of flight undoubtedly drifted considerable distances. Dr. W. L. McAtee records crossing Currituck Sound, N. C., a distance of 6 miles, during which caddis-flies and midges were so numerous over the water that vision was perceptibly restricted and one was constantly annoyed by the impacts of the insects against the face.

These latter records suggest that insects may drift with the wind, and the question may well be raised as to the agencies which make possible the long trips mentioned above. We have become so accustomed to a determinate migration by birds that there is a strong tendency to explain insect movements in the same manner. It is quite possible that some insect movements are direct responses to a migration impulse, but on the other hand there is no proof that such is the case in regard to some of the wanderings discussed above. The physical exertion involved in a 2000-mile trip against the wind is so great that one may reasonably question the ability of even the most powerful flying insects to accomplish this successfully. There is no question but that unusual gales may carry insects enormous distances in the same way that such disturbances force migrating birds far from their normal courses. These occasional and unusual wind currents

¹ Cf. *The Honolulu Monthly Magazine*, vol. 22, p. 221 (1886), and vol. 30, pp. 230-1 (1914).

do not appear to be the most effective in promoting the spread of insects, though they undoubtedly assist to a material extent. The observations of Prof. F. Wood-Jones as recorded in his "Coral and Atolls" indicate that dragon-flies go to sea of their own accord, and that they are not blown from the shore. He states that in periods of absolute calm of long duration one species of tropical dragon-fly may be seen hawking about over the sea twenty miles and more from the nearest land, and that he has observed numbers of this insect almost daily in a journey through dead calms all the way from Singapore to Thursday Island. He adds that strong-flying butterflies do the same, flying away from the land in a perfectly irresponsible way, and that moths come nightly to a ship's light when she is lying twenty miles from the shore. This condition obtains in other parts of the world, and is evidenced by the insect drift occasionally found along the shores of oceans and lakes in particular. These insects are not necessarily carried out over the water by strong winds. They are simply the normal population of the air which under ordinary conditions, in the case of the smaller lakes at least, would allow themselves to drift across the water, whereas a sudden chilling of the atmosphere, especially if accompanied by rain, results in driving many of them down into the water and their subsequently drifting ashore. According to Mr. C. B. Williams, Acting Chief Entomologist of Egypt, a number of insects drift many miles into the African deserts.

It is our belief that determinate flight is a comparatively small factor in promoting the spread of insects, and that in many cases this is accomplished largely by a drifting with the wind, the stronger flying species probably being able to remain in the air longer than their weaker associates. Much of this long distance spread is very probably made possible through the higher velocities of the upper air strata, the insects gaining these by the aid of convectional currents arising from heated surfaces and now known to extend to a height of at least 1000 feet above the surface. These upper air currents frequently have a velocity of 30, 50, or even 100 miles an hour, consequently a favourable wind for a relatively short time is all that is necessary to carry an insect long distances. This is probably what occurs rather frequently in the early autumn when swarms of "cotton-moths" (*Aletia argillacea* Hubn.), an insect unable to survive north of the cotton-growing area, appear at lights in the northern United States and southern Canada.

Even relatively high wind velocities would mean an insect remaining in the air a day or so, if it were to make the 2000-mile trip from the American continent to the Hawaiian Islands. This is probably within the physical powers of an insect, though it does not necessarily follow that a non-stop journey is made over such an expanse of water. There are several records of the smaller butterflies at least resting upon the surface of the ocean and successfully resuming flight. This has also been recorded of certain grasshoppers, and it appears possible that larger butterflies and even dragon-flies might do the same under extreme conditions.²

If the upper air currents are somewhat important carriers of insects, there should be some confirmatory evidence. It is perhaps sufficient to state here that

mosquitoes have been met with at an elevation of 3000 feet above the surface, grasshoppers at a height of 2000 feet, and honey-bees at approximately the same elevation. Plant spores have been recorded at an elevation of 11,000 feet. These last must have been carried up by convectional currents. Winds tend to drop over the cooler water surfaces and glaciers of the earth, and on these latter exceptionally large numbers of insects have been observed repeatedly, probably forced down by the falling temperatures. Furthermore, collectors on some of the high mountains, such as Mount Washington, have taken insects which are distinctly southern or south-western in habitat, probably carried there by the upper air currents and dropped upon these cooler mountain tops.

It is not suggested for a moment that the appearance of butterflies and dragon-flies in the Hawaiian and other ocean islands is anything more than the outcome of a somewhat irresponsible flight assisted by favourable winds. There is another phase or supposed phase of insect movement deserving notice, that is, the autumn assembling of Monarch butterflies and their apparent southward movement in considerable numbers. There are a number of records of apparently determinate movement by butterflies, mostly in the tropics, and a somewhat similar movement on the part of dragon-flies, in some cases immense numbers of insects coming under observation. These cases may represent a true migration, though this is scarcely established by available data. It is quite within the realm of possibilities that atmospheric or other disturbances may have resulted in an unusual condensation, as it were, of insect life, and that the movements observed followed a change in conditions and were in some instances at least an instinctive effort on the part of the insects to spread out or move away from each other, in order to secure better opportunities for food, either for the insects themselves or their progeny. The account by W. H. Hudson of the dragon-flies appearing in advance of the dry, cold "pampero" in the Argentine, and the record by Gatke of the millions of dragon-flies appearing in Heligoland in advance of a storm and their rapid scattering thereafter, are both very suggestive in this respect.

The fact that various natural causes result in large swarms of insects should not be overlooked in this connexion. The nearly simultaneous development of millions of mosquitoes, midges, caddis-flies, black-flies, and butterflies within a restricted area accounts for many swarms, and these must disperse in some way, if they are to live and provide for their progeny. A movement in any one direction is likely to establish a trend which might easily be mistaken for determinate migration. The observations of Prof. V. L. Kellogg in relation to the winter assembling of the Monarch butterfly in southern California, to revert to this insect once more, suggest that the swarms of this insect may be really the expression of a hibernating instinct rather than a preliminary to migration.

It may appear to some that a rather large part in the distribution of insects has been given to the winds, and comparatively little left to the physical ability and the desire or instinct of the insect. We are considering particularly those individuals which allow themselves to be carried by winds, and in most instances they are

² Cf. Seitz, *Macro-Lep., Palæarctic Region*, 1, p. 77, *Danizda plexippus*

a relatively extremely small proportion. It is very probable that many of these widely ranging forms are somewhat local, if that term is not interpreted too narrowly. On the other hand, we should not expect winds to do less for insects, forms inheriting most admirable organs of flight, than for such wingless creatures as spiders. McCook, a well-known authority, states that ballooning spiders have been found more than 200 miles from land and at elevations of more than 1000 feet. He has concluded from a study of distribution in the tropical regions that these spiders may have actually circumnavigated the globe on the wings of the wind. The known distribution of certain small insects in tropical areas likewise suggests that winds may have played a most important part in carrying these minute, fragile insects. In other words, the ability of the organism to support itself in the air appears to be a most important factor in certain types of distribution.

There is very little question but that representatives of many species of insects are carried far beyond any point where they can possibly maintain themselves. Nature is extremely profuse in her provisions for the continuance of both plant and animal life; the greater

the hazard, the more liberal the provision as a rule. It appears reasonable to conclude that winds are carrying millions of insects daily into regions where they cannot possibly survive. A few especially favoured forms may by chance find their way to an area where there are livable conditions. One of the notable instances of this kind was the appearance of a caterpillar on the first crop of tomatoes and peas raised from seed in the out-of-the-way Cocos-Keeling Islands, although it was not a native species, and the parent moth must have travelled hundreds of miles over an inhospitable ocean. A similar case came to the writer's attention recently in connexion with a small patch of corn growing in a Chilean desert. Insects are all about us. Only occasionally do we realise the frequency with which they appear in unexpected places.

Fortunately for man, many of the more destructive species find themselves unable for one reason or another to take advantage of the wings of the wind. An economic application is that insect spread may be somewhat definitely limited by the winds which prevail when other conditions are favourable for dissemination.

Obituary.

DR JOHN M. CLARKE.

JOHN MASON CLARKE, who died at Albany, New York, on May 29 last, was one of the foremost palaeontologists of America. The son of a schoolmaster at Canandaigua, New York, he was born on April 15, 1857, and received his early education in the school which his father directed. He was inclined in boyhood to the study of geology and natural history, and he proceeded in 1873 to Amherst College, Mass., where he graduated in 1877. At Amherst he came under the influence of the professor of geology, B. K. Emerson, and so entered on his life-work. He began to study in earnest the Upper Devonian rocks and fossils in the neighbourhood of his home, and while holding a succession of small teaching appointments devoted all his leisure to original research.

By the end of 1884 Clarke had made so much progress, that he felt impelled to compare his results with those of European geologists, and he went to spend parts of two years studying under Prof. A. von Koenen in the University of Göttingen. There he graduated with a thesis on Devonian geology in 1885, and after holding another small teaching post, was eventually appointed assistant to Dr. James Hall, the well-known State Palaeontologist of New York, in 1886. Thenceforward until his death he was connected with the Geological Survey of New York, becoming State Palaeontologist in 1898, and State Geologist as well as Director of the State Museum in 1904.

Clarke's earliest papers on Devonian fossils were published in 1882, and were followed by a long succession which culminated in his two classic volumes, "The Early Devonian History of New York and Eastern North America," published by the Geological Survey of New York in 1908-9. At the same time he studied the Devonian fossils not only of Germany, but also of Brazil, Argentina, and the Falkland Isles. Among his

official duties he was also concerned with several other Palaeozoic faunas, and he became the recognised authority on Palaeozoic invertebrata in America. With Dr. James Hall he published "An Introduction to the Study of the Genera of Palaeozoic Brachiopoda" in 1893-94; and with Dr. Ruedemann a monograph of "The Eurypterida of New York" in 1912. Both these are works of reference of permanent value.

In later years Clarke made good use of his ripe scholarship in considering some of the wider problems of the science to which he had devoted his life. As first president of the Palaeontological Society of America, in 1911 he delivered an address on "The Philosophy of Geology and the Order of the State," and in 1921 he published a little memoir entitled "Organic Dependence and Disease." He applied his science to questions of state control, and argued that it pointed to individualism, not socialism, as the essence of progress.

Clarke was an attractive personality with very wide interests beyond those of his special work. As head of the State Museum he also controlled the science division of the department of education, and he was associated with many other organisations in the city of Albany. He will be mourned not only as an eminent man of science, but also as a model citizen.

A. S. W.

MR. D. R. STEUART.

DANIEL RANKIN STEUART, late chief chemist to the Broxburn Oil Co., Ltd., died at his residence, Blackhall, Edinburgh, on August 1. He was a well-known figure in scientific circles in the east of Scotland, and was a recognised authority on the chemistry and technology of shale oil and petroleum. Born at Bogside, Lanarkshire, in 1848, he studied botany and geology in his early youth, and, for reasons of health, spent some ten years in the open-air pursuits of gardening and farming, he received his chemical training at

the University of Edinburgh under Crum Brown, at Glasgow under Dittmar, and finally at Munich. His connexion with the shale oil industry, destined to be a lifelong one, began about 1875, when he became a laboratory assistant to the late Sir George Beilby at the Oakbank Oil Works. In 1877 he was appointed chief chemist to the Broxburn Company, and retired from that post five years ago.

Mr. Steuart was a strenuous worker, endowed with a mind of exceptional intellectual insight and power. His writings are well known, and include a number of articles, contributed to the Transactions of the Society of Chemical Industry, on the shale oil industry, petroleum, and brown coal; some of these are of practical interest, others in speculative vein. To the same Society he read a paper entitled "The Oxidation of Mineral Oils," and edited and read one by his nephew, Mr. B. Steuart, on "The Composition of Shale Naphtha." It was one of his regrets that his routine duties did not permit him to devote more time to organised research; he, however, strongly advocated the desirability of industrial research being taken up by qualified university workers. That his eminence as an authority on shale was widely recognised is attested by articles written by request to "Economic Geology" (U.S.), Ure's "Dictionary," Muspratt's "Chemistry," Thorpe's "Dictionary of Applied Chemistry," and an important contribution to the memoirs of the Scottish Geological Survey entitled "The Chemistry of the Oil Shales." In the last mentioned he propounded a theory referring to the origin of oil shales.

Mr. Steuart's humane instincts led him, in 1890-95, to direct public attention to the number of deaths caused by the use of low flashing burning oils in lamps. He wished the standard of flash point to be raised from 73° F. to 100° F., and gave evidence on the subject before a Select Committee of the House of Commons during the reading of the Petroleum Bill. The measure was unsuccessful, but as the light constituents of petroleum (the cause of low flash point) afterwards became valuable as motor fuel, Mr. Steuart had the satisfaction of seeing burning oils made safer by the elimination of much of the danger in the refinery.

R. H. FINDLATER.

PROF. O. BREFELD.

THE death was recently announced of Prof. Oscar Brefeld, the founder, and for fifty years a leader, of modern mycology. Born at Telgte in Westphalia, on August 19, 1839, the son of a wealthy pharmacist, whose business he was intended to inherit, he early took an interest in the lower plants, but it was not until 1868 that he began his mycological studies in earnest. At the outset he realised the necessity of sterilising the culture media and the apparatus, and of studying microbes and spores as individuals. For this purpose he introduced gelatine—which he replaced later by agar-agar—and devised the method of pure culture by thinning the medium so as to grow a colony from a single cell under continuous microscopic observation. Thus he laid the foundation of all subsequent microbiological study ten years before R. Koch took up the inquiry.

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In 1870 the contemporary work of Pasteur led a Munich brewer to seek the assistance of Brefeld. Here he gained experience and a crop of fruitful ideas, but his work there was cut short by the Franco-Prussian war. From the siege of Paris he was invalided home after an attack of typhus and prosecuted his studies in Berlin. Here he took his doctor's degree, and in 1872 published the first volume of his great life work, "Botanische Untersuchungen aus dem Gesamtgebiete der Mykologie" (18 vols.), known as the mycologists' Bible. The following year saw the publication of his epoch-making researches on the Ascomycetes, especially on the cultivation of the blue mould *Penicillium glaucum* from a single spore to a mycelium with complete fructification. One cannot here go through the contents of successive volumes, but his important work on *Bacillus subtilis*, undertaken for the Prussian Government in 1878, demands mention. Brefeld did not, however, pursue bacteriology, feeling that his medical knowledge was too slender. Robert Koch was therefore substituted to become the "German Pasteur."

Brefeld, after habilitating as privat-docent in Berlin, became, in 1876, professor at the Forestry Academy in Eberswalde. Here he lost the sight of one eye. As a consequence of the "Kulturkampf" he was urged by the Government to become professor of botany at Münster in Westphalia. Here he continued to publish the most valuable work, until his removal to Breslau in 1898. In the year before the War, Brefeld resided in Berlin, where he lectured; but he became completely blind and had to resign his professorship.

Brefeld was a hard worker, entirely bound up in his life-work. He did not care to have pupils, but he trained a succession of assistants, among whom may be mentioned the Germans, Zopff, Alfred Möller, and R. Falck; the Norwegians, Holtermann and Sopp, the Swiss, Von Tavel; and the Hungarian, Gyula de Istvanffy. We are indebted to an article by Dr. Sopp in a recent issue of *Nature* for the details of Brefeld's life.

We learn from the *Chemiker-Zeitung* with much regret that on August 4, shortly before his fifty-fifth birthday, Dr. Friedrich Auerbach, younger brother of the physicist Dr. Felix Auerbach of Jena, and well known as the collaborator with Abegg in the "Handbuch der anorganischen Chemie," died suddenly of heart failure. Auerbach studied at his native town, Breslau, under Ladenburg, to whom for a while he acted as assistant, after which he was engaged for several years in industrial work. But his real interest lay in scientific investigation, and in 1903 he returned to Breslau, where Abegg had recently begun to build up a flourishing school of chemistry. Shortly afterwards he was transferred to the Imperial Health Department. At Breslau, Auerbach devoted his attention chiefly to physical chemistry, and he published many papers dealing with the theory of electrolytic dissociation and the theory and practice of the electrometric titration of acids. After the death of Abegg in 1910, Auerbach undertook the onerous task of editing the "Handbuch der anorganischen Chemie." Before the War he was a member of the International Association of Chemical Societies.

Current Topics and Events.

A LARGE party from Section D (Zoology) of the British Association visited Hayling Island on Monday for the formal opening of the British Mosquito Control Institute which has been built there by Mr J. F. Marshall. Anti-mosquito work was commenced at Hayling in 1920, and we have on several occasions referred to the very valuable results achieved. By draining and other operations, the mosquito nuisance in the district has been almost entirely removed, and the measures adopted have been followed with success at other places around the coast. Mr Marshall's work in connexion with both salt-water and fresh-water mosquitoes has become so widely known that inquiries from medical officers and others continually reach him from many parts of the country, and numerous people interested in the subject have visited Hayling to see his laboratory and his control work in inter-tidal and other areas. This led to the erection of a building containing a demonstration museum, laboratory, drawing office, photographic room, and other facilities for study and research in various branches of mosquito control work. The building, the design and equipment of which are based upon five years' experience in the laboratory and the field, is the first example of an institution devoted exclusively to what may be termed the non-medical side of mosquito investigation. Sir Ronald Ross, in an address at the opening ceremony, described the growth of the organisation at Hayling and expressed high appreciation of Mr. Marshall's work, both as to its scientific value and practical service. We hope to give some further particulars of the Institute and the opening ceremony in our next issue.

THE recommendations of the Committee on the use of preservatives and colouring matters in food have already been noticed in these columns (February 14, p. 217). It will be remembered that the Committee considered that the use of boric and salicylic acids and their salts should be prohibited completely, that sulphurous and benzoic acids and their compounds should be permitted in certain articles of diet in quantities not exceeding a definite limit which varied according to the food, and that a list of permissible colouring matters should be drawn up. The Minister of Health has now issued regulations under the Public Health Acts dealing with this subject. (The Public Health (Preservatives, etc., in food) Regulations, 1925. Statutory Rules and Orders 1925, No. 775, and Circular 606. London: H.M. Stationery Office, 3d. and 1d.) Certain previous regulations as to the use of preservatives in butter and cream are revoked, and the use of any thickening substance in the latter is forbidden. The foods in which preservatives are allowed, whether sulphur dioxide or benzoic acid, and the maximum amount permissible, are given in a schedule: it will be remembered that the articles of diet concerned are sausages, fruit preparations, wines, non-alcoholic beverages, syrups, gelatin, coffee extract, pickles and sauces. As regards colouring matters, a short list of those forbidden has been

drawn up and includes certain metallic salts, a few coal-tar dyes and gamboge. The regulations include a section prohibiting the sale as a preservative of any article the use of which as a preservative is forbidden, and also details as to the labelling of certain of the food products in which a preservative is permissible and of articles sold specifically for use as preservatives. The regulations come into force on January 1, 1927, except in the case of butter and cream, where their operation is postponed for a further year.

THE issue of the Journal of the British Science Guild for August contains a valuable report, prepared by a committee of the Guild, on the supply of trained research workers in Great Britain and their utilisation in industry. According to it, in the year 1923-24, the number of full-time students of science at British universities was 60 per cent greater than in 1913-14; the number of students who obtained science degrees was three times, and the number engaged in full-time scientific research four times, the corresponding numbers in the former year. While the universities are in this way doing what they can to supply the industries with the research workers they require if they are to hold their positions against their competitors, the industries themselves are doing little to absorb the trained men available. This is particularly the case in the chemical industry, and the Department of Scientific and Industrial Research has taken steps to reduce the number trained in this subject. The committee recommends that a staff of research workers should be maintained in a national institution, and that any firm should be able to secure the services of one or more of them for work at its own private problems.

IN a recent address to the American Institute of Electrical Engineers, published in the June issue of the Journal of the Institute, Mr E. M. Herr discussed the future of railway electrification. Up to June 1924, the electric locomotives built and under construction in the world numbered 2351, of which the aggregate horse power was more than four million. Of these locomotives 905 were operated by direct current. In Italy there were 504 locomotives, and in the United States 465. Then came France, Germany, and Switzerland with 366, 304, and 214 locomotives respectively. No other country had so many as 150 electric locomotives in service. Great Britain, however, has constructed and is constructing a large number of electric locomotives for use overseas. One curious development in the Italian railways is the use of portable substations. These are of use in the event of a breakdown of an ordinary substation or when part of the line gets overloaded. All the devices, including 100,000 volt transformers, are carried on a railway bogie waggon frame which can be coupled to an ordinary train and travel at a speed of 50 km (31 miles) per hour. At present they are in regular use in places where the substations have not yet been constructed. One of these substations is being exhibited at the Grenoble Exhibition.

IN an address to the Water Power Congress held at Grenoble in July, a translation of which appears in *Engineering* for August 14, Mr. Bouchayer discusses the regulation of the import and export of electrical energy between neighbouring countries. In France, the demand for electric energy greatly exceeds the supply, and so the main problem is concerned with the import of electrical energy from abroad. Switzerland supplies most of the imported energy. Belgium supplies energy to both works and distributing stations. A small amount of energy also is transmitted across from Italy and Spain. The amount sold to French consumers in 1923 by the Swiss hydro-electric industry amounted to 521 million kilowatt hours and is constantly increasing. This export is watched with some misgivings by the Swiss Federal Council. They are afraid that the use of cheap hydraulic power may enable a foreign industry to compete successfully with one of their own. Should there be a drought, the export "permits" limit seriously the amount of energy that can be transported, and this may be very awkward for the foreign consumer. The suggestion is made that the Swiss law should provide for an indemnity when an authorisation is withdrawn. From the point of view of the French authorities, the import of cheap energy may prevent the development of French hydro-electric power, which, as it has in general to be transmitted over long distances, cannot be sold so cheaply. Mr. Bouchayer suggests that an inquiry should be held and also that a tax should be put on energy imported over a distance of 100 km. (62 miles) into France. The tax suggested is 0.005 franc per kilowatt hour. Electrical energy should only be imported within the limits required by the national interest.

THE Rowett Research Institute has recently issued Volume I. of Collected Papers consisting of 62 communications to a score of different journals. All but two of these have been published within the last five years. The wide distribution of these publications, serving as they do the sciences of agriculture, bacteriology, chemistry, and medicine, make it most convenient to have all the publications in one volume. The name of the editor of the volume, Dr. J. B. Orr, Director of the Institute, is associated with half the papers. The field of research covered by a number of investigators in four different departments is naturally extensive, but the activities of the Institute as a whole have been focussed on problems of nutrition. Although much work has been published on the subject of calorimetry, the staff, while recognising the importance of this aspect of nutrition, realised that other essential factors had in the past been neglected. Several papers are devoted to work on vitamins, but this work seems to have stimulated a reluctance to accept the explanation of deficiency of these accessory factors as the chief cause of lack of growth and of such diseases as rickets, attributed to vitamin deficiency by the majority of modern investigators. Other possible explanations have therefore been sought; the neglected field of mineral metabolism offering the most scope for work. The possibility of a lack in

the food supply of any of the normal mineral constituents of the animal body, *e.g.* calcium, phosphorus, iron, etc., and the effects produced by deficiencies of these substances, are complicated by hypotheses of the necessity of rigid mineral balances in the food, thus presenting a very wide field for investigation. The Rowett Research Institute is to be congratulated on the whole-hearted way in which the staff has attacked these problems, for much more work on animal nutrition is urgently required by our oldest industry to make good the deficiencies arising from new animal environments. It is well to remember, however, that this is the output of only five years' work, and the too speedy application of scientific results to agricultural practice has its dangers.

THE British Research Association for the Woollen and Worsted Industries, Torrington, Headingley, Leeds, is awarding next session a number of research fellowships and advanced scholarships. The fellowships will be of the annual value of not more than 200*l.* each and are tenable at an educational institution or at a works. The scholarship grants are such as to cover expenses and maintenance and are intended to enable students to specialise after completing their secondary or university education; they are also open to factory workers. A wide choice of studies is available to textile students who enter for these scholarships.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned. An assistant lecturer in agricultural zoology in the department of agriculture of the University of Leeds—The Registrar, The University, Leeds (September 14). A lecturer in metallurgy in the University of Liverpool—The Registrar, The University, Liverpool (September 15). A secretary to the Public Instruction Committee, Jersey—The President, Public Instruction Committee, Greffe Office, Jersey (October 1). The Jenner Memorial Research Studentship at the Lister Institute of Preventive Medicine—The Secretary, Lister Institute, Chelsea Bridge Road, S.W.1 (October 3). A director of the new pharmacological laboratories of the Pharmaceutical Society of Great Britain—The Secretary, Pharmaceutical Society of Great Britain, 17 Bloomsbury Square, W.C.1 (October 5). A senior lecturer in philosophy in the University of Melbourne—The Agent-General for Victoria, Melbourne Place, Strand, W.C.2 (October 15). A director of the department of medical entomology, and lecturer on noxious and venomous animals, at the London School of Hygiene and Tropical Medicine (Division of Tropical Medicine and Hygiene)—The Secretary of the School, 23 Endsleigh Gardens, N.W.1 (October 31). An assistantship in the Department of Logic of the University of Glasgow—The Secretary, The University, Glasgow. A junior scientific assistant in the ignition and electrical department of the Royal Aircraft Establishment—The Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (quoting A. 78). A chemist in the establishment of a large textile firm—The British Woollen Research Association, Torrington, Headingley, Leeds.

Our Astronomical Column.

PLANETARY TEMPERATURES—Dr. W. W. Coblentz's pioneer work on the measurement of the heat of the stars by means of the vacuum thermocouple is well known. In conjunction with Dr. Lampland of the Lowell Observatory, he has recently made similar observations of the heat radiation of the planets and the moon, and the results are published in the June and July issues of the *Journal of the Franklin Institute*. The substances water, quartz, glass, fluorite and rock salt are found to be practically opaque beyond the wave-lengths 1μ , 4μ , 8μ , 12μ , and 23μ respectively, whilst the atmosphere itself is opaque beyond 15μ . By the use of screens made of the materials mentioned, it was therefore possible to obtain thermocouple measurements of the radiation incident in the regions 0.3μ to 1μ , 1μ to 4μ , 4μ to 8μ , 8μ to 12μ , and 12μ to 15μ . From these measures the true planetary radiation could be found by subtracting the reflected solar light (0.3μ to 1μ) from the total radiation, and the spectral composition of the remainder enabled the planetary temperature to be estimated.

The most interesting of the results are those referring to Venus and Mars. Observations on Venus showed that when the bright phase was a narrow crescent, the dark part emitted an intense planetary radiation (in the region 8μ to 12μ) amounting per unit area to one-tenth of the total radiation from the bright crescent. It is pointed out that this suggests either a short rotation period for the planet or a hot interior. The region near the south cusp was hotter than that near the north, but long-continued observations will be necessary to settle whether this is a seasonal effect. If it is seasonal, the possibility of determining the position of the axis of rotation is foreshadowed.

Extensive observations of Mars were made during the opposition of 1924. The dark regions were found to give an appreciably higher temperature than the bright regions. The noon-day temperature of the bright regions on the equator came out as 5°C , that of the adjacent dark regions as 20°C . At the same time the east (sunrise) limb gave -45° , the west (sunset) limb 0° . These results show a huge diurnal range of temperature for points on the equator, indicating a rare atmosphere. The temperature of the north polar region was found to be steady at about -70° , but that of the south polar region rose gradually from -68° to $+10^\circ$ as the summer season in the southern hemisphere advanced. The temperature of the night-side is thought to be probably below -70°C . The integrated temperature of the whole disc was -30°C for the month of July 1924.

THE GRONINGEN ASTRONOMICAL LABORATORY.—This institution, founded by Prof. Kapteyn, is continuing its labours under the direction of Prof. P. J. Van Rhijn. Publications 36, 37, 39 have recently come to hand. No. 37 is a discussion of the systematic errors of the trigonometrical and spectroscopic parallaxes published by several observatories. It is well known that systematic differences exist in the parallaxes found at different observatories. Prof. Van Rhijn seeks to determine the true values by correlating angular proper motions with linear velocities for different groups of stars. Systematic errors in the assumed trigonometrical parallaxes necessarily enter also into the spectroscopic ones, since the curves of line-intensity are based on trigonometrical results.

Prof. Van Rhijn revises the Groningen statistical parallaxes given in publication 34, reducing them on the average by 10 per cent. Comparing them with the Victoria spectroscopic parallaxes, he finds the following corrections to the latter: Spectral types F, G, K, correction $-0.005''$; type M $+0.004''$.

Publication 36 is a study of the number of stars of

each spectral class between definite limits of proper motion, visual magnitude and galactic latitude.

No. 39 is a list of 656 proper motions of faint stars deduced from Helsingfors plates. The largest two centennial motions are $129''$ (mag. 10.2) and $38''$ (mag. 13.1).

MULTIPLE STARS—F. Henroteau, of the Ottawa Observatory, contributes an interesting paper to the July issue of *La Science moderne* describing some multiple stellar systems. Many of these are studied spectroscopically, and also photometrically with the photo-electric cell.

σ Scorpii consists of a Cepheid, the pulsation period of which is about 6 hours, having a companion with orbital velocity of some 35 km/sec and period 33 days. There is a more distant companion the period of which is 12 years. The motion of the Cepheid in this large orbit causes its light variations to be alternately accelerated and delayed, owing to the change in its distance.

σ Cygni is stated to have a density $\frac{1}{100}$ of the sun's, and a mass 10 times the sun's, while its companion has a diameter $\frac{1}{2}$ of that of the primary, and a mass $7/100$ of the sun's, which if confirmed would make it the least massive body yet recognised outside the solar system. Rigel and α Cygni are suspected to have similar small companions, but the detection of such small masses by changes in the line-of-sight velocity is necessarily a very delicate matter.

Prof. Guthnick has studied the eclipses of σ Cygni photometrically, and states that they last about 3 days, their period of recurrence being 11 days.

OBSERVATIONS OF STARS OF SPECTRUM TYPE Be—Stars of spectrum type B are hot stars, and those which show bright lines in their spectrum are of particular interest because their study will no doubt throw light not only on the conditions of their atmospheres, but may also help to interpret the spectra of new stars and unusual properties of the hydrogen atoms. In the spectra of these stars the hydrogen lines are sometimes very complex, such as was recently described in this column in the case of ϕ Persei as studied at the Norman Lockyer Observatory by Dr. W. J. S. Lockyer. The intensity of the bright hydrogen lines usually decreases from the red to the violet, and as the ordinary photographic spectrum only extends from H β to the ultra-violet, it might occur that while H β and the other lines towards the violet were not bright, the line at H α might appear as a bright line. In fact, most of the so-called bright-line B stars have been discovered because H β or the other hydrogen lines towards the violet were bright.

A recent investigation by Paul W. Merrill, Milton L. Humason, and Cora G. Burwell (*Astrophysical Journal*, vol. 61, p. 389, June), has been devoted to the study of the H α line of B stars, with the result that 90 more bright-line B stars have been discovered. Indeed the discussion brings out the fact that the objective-prism spectrograms have yielded more new bright-line stars than the number previously known within the areas observed. This great increase in the number of these stars has led the authors to inquire into their distribution in the heavens. The result of this study is to show that there is a tendency for them to fall into groups near the centre line of the Milky Way. Four of these groups occupy areas which are also rich in Wolf-Rayet stars. Further, the frequency of bright-line stars in the various spectral divisions has also been examined, and it is found that the spectrum classes B0 to B5 are strongly favoured. The communication includes numerous tables and illustrations, and is a valuable contribution to the study of bright-line stars.

Research Items.

QUATERNARY MAN IN CHINA.—An important addition to our knowledge of the distribution of man in the Pleistocene age is made by the researches of MM. Licent and Teilhard de Chardin, of which a preliminary account is given in Vol. 35, Pts. 3-4 of *L'Anthropologie*. While engaged in examining the quaternary deposits of southern China, they discovered three sites affording evidence of occupation by palæolithic man. The first is situated in the basin of the Choei-tong-k'euou immediately to the south of the Ordos plateau and to the east of the Yellow River, where was found a sharply defined zone of occupation of about 20 m. in length with a deposit of 50 cm. thickness. Upon it was superimposed a bed of loess about 15 m. deep, and above this the gravels of a pre-neolithic river. No human remains were found, but a quantity of fossil bones of *Bos primigenius*, *Rhinoceros tichorhinus*, *Hyæna*, and the tooth of, probably, *Ovis Ammon*. Stone implements were very numerous and of various forms, all being worked on one side only. They were rude in form and rough in workmanship, this being due to the coarse grain of the material employed. At the same time a few scrapers and points showed that, given suitable material such as flint, man here was capable of fine work. Five hearths were discovered in the neighbourhood within an area of about a square kilometre. The third site was found on the Sjarosso-gol, a tributary of the Hoang-ho, and has yielded the complete skull of a rhinoceros, and bones of a species of elephant, *Rhinoceros tichorhinus*, *Equus*, *Cervus*, *Bos primigenius*, *Hyæna spelæa*, etc. The lack of suitable material in this area has affected the character of the stone implements, which, with a few exceptions, are extraordinarily small. Notwithstanding this difference, this site and that at Choei-tong-k'euou may be regarded as contemporary. No traces of industry intermediate in date between this palæolithic culture and the neolithic have been discovered. Although comparison with European cultures is difficult, these sites may be classed as Mousterian or early Aurignacian.

OBSERVATIONS ON A COLLARED FLAGELLATE—Dr. G. Lapage (*Quart. Journ. Micr. Sci.*, June 1925), records observations upon living specimens of the choanoflagellate *Codosiga botrytis* made with the view of ascertaining the nature of the collar and its function as a food-catching apparatus. Study of the organism does not support the view put forward by some previous observers that the collar is a spiral; Dr Lapage holds that it is, as earlier workers stated, a protoplasmic, flexible, retractile, conical membrane, closed on all sides except on its upper free surface. The flagellum which arises in the base of the cup and the currents it produces are carefully described. They cause food to be brought to the collar, by which it is caught and passed down the outside of that structure to be ingested at or below the middle of the body, and not at its upper end and never by the area enclosed by the collar. The method of ingesting the food is fully described. Defæcation invariably occurs from the area enclosed by the collar. There are normally two contractile vacuoles; one of these has been misinterpreted as a "gullet-vacuole" at which food was said to be ingested. Dr. Lapage has not met with any examples which exhibited division, encystment, or conjugation.

RECOVERY FROM PLASMOLYSIS—It has been almost axiomatic amongst botanists to interpret recovery from plasmolysis, when a living cell is immersed in a hypertonic salt solution, as due to the gradual entry of the salt. When the plant cell is immersed in sugar

solution or in solutions of certain salts, no recovery takes place and the sugar or the salt in question is assumed not to penetrate the cell. This interpretation of recovery from plasmolysis will need reconsideration in the light of a recent paper by W. S. Iljin (Studies from the Plant Physiological Laboratory of Charles University, Prague, vol 2, 1924). Iljin points out that the salts which have thus been assumed to penetrate the cell all appear to possess the property of facilitating the hydrolysis of polysaccharides such as starch. The result is the formation of soluble organic compounds within the cell, which raise its osmotic pressure in many cases to a value far higher than would be attained simply as a result of the entry of the salt itself. Salt solutions in which recovery from plasmolysis does not take place also fail to promote hydrolysis of starch. How the monovalent cations and organic anions thus found to be active in hydrolysis produce their effect is not apparent, but Iljin is emphatic that he sees no evidence of any considerable penetration of the cell by these ions.

NORTH-EAST LAND, SPITSBERGEN.—Mr. F. G. Binney gives an account of the Oxford expedition to North-East Land in the *Geographical Journal* for July. This is followed in the August issue by summaries of the scientific results by various members of the expedition. Some additions to the topography and geology have been made. On the east coast a low-lying spit of granitic and metamorphic rock was discovered and named Isis Point. Its position was found to be lat. 79° 42' N., long. 26° 40' E. No islands, such as had previously been reported, were found off the east coast. Soundings showed that the ice cap along this coast is aground and not floating and there is evidence that it is receding at no mean rate. In the interior of North-East Land no features exactly tallying with A. E. Nordenskjöld's "ice-canals" were found but wide crevasses with parallel vertical sides were numerous. They were of great depths and often partly choked with snow, but a definite floor such as Nordenskjöld described was never seen. It is probable, however, that these crevasses were of the same nature as the features discovered by Nordenskjöld.

RAINFALL VARIATIONS OF GREAT BRITAIN.—The *Meteorological Magazine* for June contains an article by Mr. C. E. P. Brooks, of the Meteorological Office, on "Long Period Variations in the Rainfall of Great Britain." The author makes a praiseworthy attempt at grouping past records of rainfall and associating with them the earlier historical records of weather such as storms, floods, and droughts. With the aid of previous work done by G. J. Symons, E. J. Lowe, and Sir Richard Gregory, an approximation is made of the variations of rainfall in Britain since A.D. 1000. Approval is expressed of conclusions obtained by Symons, which is a satisfaction to those who knew Symons' work, and the scrupulous care with which he originated and handled rainfall results. A diagram is given to show the fluctuations of rainfall since A.D. 1000. Prior to 1700 the results are based on generalisations by old chroniclers, and it is only claimed that a rough approximation is obtained; but from 1700 onwards the results are based on actual measurements. There is probably no one who can better claim respect in this research than Mr. Brooks, and the article is of especial interest.

INSTANTANEOUS COLOURED PHOTOGRAPHY.—A method of obtaining coloured photographs by means

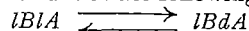
of a single very short exposure is described by M. G. A. Rousseau in the *Comptes rendus Acad. Sci. Paris*, July 20. Three films are employed, the first of which has an ordinary slow emulsion, the second is coloured yellow with auramine on the side towards the lens, and pale rose with fuchsine on the other side, and has an emulsion which is sensitive to yellow and green, while the third film is coated with an emulsion which is sensitive to yellow and red. The three films are cemented together along one edge, and pressed together in the camera by means of springs between a thin metal plate and a glass plate. The photograph is taken in the same way as an ordinary one, no screen being required. The blue-violet radiations act on the first film, and are largely absorbed by it. When this is developed it serves as a yellow positive. The radiations which pass through the first film are further filtered by the yellow dye on the outside of the second film, so that no blue-violet radiations pass to the sensitive layer, which is acted on by the yellow and green radiations giving a red positive. Finally, the remaining yellow and green is filtered out by the fuchsine on the back of the second film, so that only the orange group passes to the third film, which gives a positive in which the bright parts correspond to the blue in the object photographed. Monochromes can then be printed in the proper colours from the three films, and when these are superposed, the object photographed is seen with its natural colours.

POLARISATION OF THE ATOM TRUNK—The observed differences between the spectra due to a photo-electron, which circulates in orbits at a distance from the nucleus considerably greater than those of the remaining $n-1$ electrons, and the spectrum calculated from the Balmer formula of hydrogen, have been ascribed to the fact that the photo-electron polarises the atom trunk, so that the configuration of the trunk, to a certain extent, follows the radius vector of the electron in synchronism. The result may be to introduce a term into the law of the force field in which the electron moves, depending on $1/r^3$ or some higher inverse power of r , the distance from the centre of the nucleus. In the *Annalen der Physik* for June, Dr E. Schrodinger calculates the capacity for polarisation, P , of the "neon" trunk for the d terms ($k=3$), and the f terms ($k=4$) of Na I, Mg II, Al III and Si IV, and finds that P is nearly constant in each series when n varies from 3 to 7. A table based on the arc spectra of the alkali metals (inert gas trunks) shows some regularities and some irregularities in the values of P . A remarkable irregularity discovered by Paschen in the Bergmann series of Al II is explained by assuming that, for frequencies a little smaller than the resonance frequency of the trunk, P is large, and for higher frequencies is negative; this depends on the loosening of the structure of the trunk at the resonance frequency. The relations for the arc spectra of the alkaline earths are not very clear, and the explanation given in the case of Al II is to be taken with a certain amount of reserve in consequence.

SULPHUR SESQUIOXIDE.—The *Journal of the Chemical Society* for July 1925 contains an interesting paper by J. R. Partington and I. Vogel on sulphur sesquioxide. There has always been some doubt as to whether the blue substance formed by the interaction of sulphur and sulphur trioxide was a definite compound or a colloidal solution. The present authors have proved that it is a compound, S_2O_3 , analogous to the well-known $SSeO_3$ and $STeO_3$, which are formed in a similar way. The properties of the oxide are described as well as futile attempts to isolate sulphur monoxide.

NICKEL.—Dr M. Cook contributes an interesting article on nickel to the *Chemical Age* for August 1. Copper-nickel alloy was in use so early as 235 B.C., but nickel itself was not isolated until 1751, by Cronstedt. The chief sources are the ores of Sudbury (Canada) and New Caledonia. Pure nickel cannot, in general, be worked, it is made malleable by the addition of about 0.1 per cent. of magnesium, a discovery due to Fleitmann. The function of the magnesium is to break down the nickel sulphide which occurs as films around the nickel crystals and so renders the metal brittle. Magnesium sulphide, insoluble in molten nickel, is produced and occurs disseminated throughout the solid metal. The influence of various impurities on the properties of the metal is discussed. The mechanical properties of the metal are listed and the numerous methods of working are briefly described. Some of the toughest non-ferrous alloys known contain nickel. The metal is finding numerous uses, and more than seventy countries utilise it or its alloys for coinage purposes.

DIAGNOSING POTENTIAL OPTICAL ACTIVITY.—An important article on the detection of potential optical activity, by Prof. John Read and Miss A. M. M'Math, appears in the July number of the *Journal of the Chemical Society*. Until 1914 no one-carbon molecule had been obtained in optically active modifications. In that year, however, Sir William Pope and Prof. Read succeeded in resolving chloro-iodomethanesulphonic acid, and found that the active forms showed pronounced optical activity. This rendered the lack of success which was experienced in attempting to resolve chloro-bromomethanesulphonic acid all the more remarkable. Prof. Read and Miss M'Math have now found that by salt-formation between this acid and *l*-hydroxyhydrindamine in organic solvents, and subsequent recrystallisation from acetone containing a little methyl alcohol, two salts are produced which differ widely in crystalline form and solubility. Their specific rotatory powers are different in organic solvents, but identical in water, and both salts show a remarkable mutarotation in certain organic solvents. The authors adduce evidence to show that these salts are to be represented as *l*B*l*A and *l*B*d**l*A respectively, and that in pure dry acetone either of them rapidly attains an equilibrium of the following kind:



81 per cent 19 per cent

The diastereoisomeric salts thus exist in dynamic equilibrium, and the whole of the original acid may be removed in the form of the less soluble salt, *l*B*l*A. This salt changes instantaneously into the partial racemate, *l*B*d**l*A, in contact with water, which apparently exerts a potent catalytic racemising effect even when added in small amounts to solutions of *l*B*l*A in organic solvents. The authors advance the view that asymmetric carbon compounds of simple molecular constitution are as a rule exceedingly susceptible to racemisation, owing to the mobility of the groups attached to the asymmetric atom. Easy racemisation involves the complementary possibility of easy optical stabilisation under an appropriate asymmetric influence, and the new method of diagnosing potential optical activity is based upon this principle. The authors "anticipate that asymmetric compounds containing two carbon atoms in the molecule will also display phenomena of the kind now described, and thus lend themselves to preparation for the first time in optically pure combinations by treatment with optically active bases in organic solvents. Through a systematic application of the method to asymmetric compounds of simple molecular constitution, it is hoped to gather much new information respecting the comparative mobility of groups in systems of the kind."

Developments in Gas Calorimetry.

By Dr. J. S. G. THOMAS.

SECTION 5 of the Gas Regulation Act, 1920, requires that, in certain cases, apparatus for testing towns' gas "shall include a calorimeter for the production of a continuous record of the calorific value of the gas which is being supplied." During the interim period of development of a suitable and satisfactory recorder, the statutory testing of the calorific power of gas has, in accordance with the specification of the Gas Referees, been done in practically all cases by determinations of calorific power made at specified periods with a Boys calorimeter. The cost and elaborate procedure at present necessitated by this method of testing have become a serious burden,

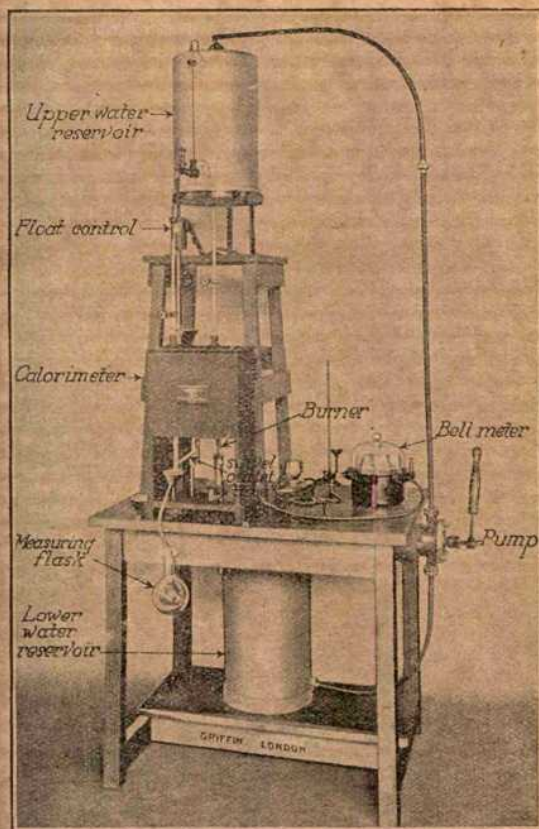


FIG. 1.

particularly in small country places, and with the view of reducing these difficulties Prof. C. V. Boys has designed a simple equipment which he described at the meeting of the Institution of Gas Engineers on June 10 last. The apparatus is illustrated in Fig. 1.

Water required for the test is contained in an upper reservoir, and after passing through the calorimeter is received in the tank or lower reservoir below the table, whence it may be restored to the upper reservoir by operation of the handle of the pump, the water entering at the bottom of the upper reservoir, so that by continuing the pumping operation air is forced into the water, the consequent stirring ensuring uniformity of temperature. The customary overflow funnel system for determining the water rate through the calorimeter has been replaced by a float control, resembling a carburettor in design. Water passes from the calorimeter by a swivel outlet tube moving between stops, so that the water may either flow to

the lower reservoir or be collected in a measuring flask during the actual test. Prof. Boys has, very reluctantly, been obliged to abandon the use of "onazote" which he employed in the construction of his "Block" calorimeter as a water-containing and insulating material, and has reverted to a construction very similar to that employed in his recording calorimeter (NATURE, August 19, 1922, p. 251) for the water circulation within the present "Box" calorimeter.

Gas to be tested is efficiently governed and passes through a micrometer tap to a Boys "Bell Meter," and thence to a burner consisting of a narrow inner tube terminating within a plain silica tube open above and below. There are no moving gas connexions, and as the gas is somewhat aerated before combustion it is possible to burn as much as one cubic foot per hour without risk of imperfect combustion. Readings of inlet and outlet temperatures of the water passing through the calorimeter may be taken after the burner has been alight about 15 minutes.

The Boys "Bell Meter," shown also in Fig. 2, incorporates some of the essential features of the meter employed in Prof. Boys's recording calorimeter

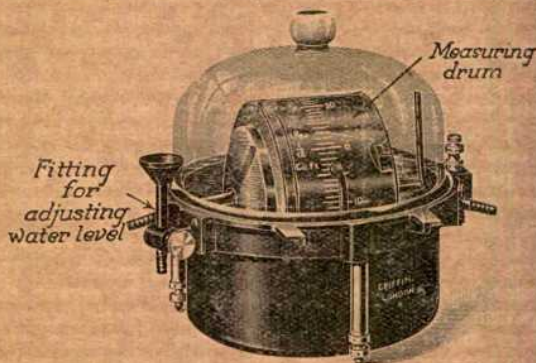


FIG. 2.—Boys "Bell Meter."

(NATURE, *loc. cit.*). A celluloid or nickel drum is graduated along its circumference and is supported on an axle moving in bearings in water, no stuffing box being employed. A buoyancy chamber supports most of the weight of the drum and forms a solid floor to the major part of each compartment of the drum when gas is trapped within it. The water level is determined by a submerged needle. Water may be added to or run off from the meter by means of the fitting seen on the left of Fig. 2. By these means the tiresome operation of meter-proving becomes unnecessary.

In the case more especially of small gas undertakings, where financial considerations unduly limit the number of tests of calorific power of the gas supplied, it is difficult to ascertain the mean value of the gas supplied over the statutory period. The consequence of the present procedure is that small gasworks, in order to prevent an adverse report, have to provide gas which on the whole is of higher calorific value than that declared. Prof. Boys suggests tentatively that in the case of such undertakings the gas supply over any period should be sampled by being slowly and continuously drawn into a small holder in the testing place, maintained if necessary at a uniform temperature, and that the sample so collected should be tested by the Gas Examiner. Owing to the small rate of gas flow and the short time taken, less than half a cubic foot of gas is sufficient for a test. In an apparatus designed by Prof. Boys for such sampling,

the gas lifts a balanced bell at a rate controlled by a clock. A chain from the bell to a balance weight made as a sprocket chain passes over a sprocket wheel connected by a clutch to a clock-turned axle, the clutch acting in such a direction that the bell cannot rise faster than the clock permits, whilst it is always free to descend when weighted. This system of clock control of sampling lends itself readily to any agreed

scheme of variation of the rate of sampling which may be considered equitable and in accordance with the variation of the rate of gas supply to the district during the hours of day and night. Should experience show that there is no loss of quality due to sampling and storage, the method would ensure one of the most important objects of the Gas Regulation Act being attained.

The Transmission of Excitation in Plants.

THE question of the mechanism of transmission of excitation in plants has been for some time under discussion in the columns of NATURE. The most recent contribution to the discussion is a paper by Sir J. C. Bose, entitled "Physiological and Anatomical Investigations on *Mimosa pudica*," published on August 1 in the Proceedings of the Royal Society (No. B 690, vol. 98).

The first section of the paper is devoted to the vexed question of the nature of the process of transmission. It has been suggested by Prof. Ricca that it is purely physical; a stimulating substance (hormone), produced at the seat of stimulation, is conveyed to the motile leaves by means of the transpiration-current in the vessels of the wood. Another suggestion, that of Mr. R. Snow, is to the effect that whilst Prof. Ricca's explanation may apply to transmission through relatively long distances in the stem, it does not apply to the petiole, where the excitation seems to travel from cell to cell. Sir J. C. Bose arrives at the conclusion that the process of transmission is the same in both stem and petiole; that it is not physical in either, but is wholly physiological, a wave of protoplasmic excitation, just as it is in the nerve of the animal.

The experimental evidence upon which his conclusion is based is both negative and positive. The author failed, after many attempts, to repeat the experiment upon which the transpiration-current theory depends, that is, to observe the transmission of excitation from one piece of stem to another connected with it by a glass tube containing water. Further, if the physical theory be true, it is obvious that the velocity of the transmission of excitation and that of the transpiration-current must be the same; but it was found that the former is far greater than the latter.

On the positive side, Sir J. C. Bose observed that transmission in *Mimosa* was affected experimentally in the manner well known in animal nerve. For

example, in both the velocity of transmission is increased by rise of temperature and by desiccation. Again, on passing a moderately strong electric current (6 volts) through a length of the stem, the effect at "make" of the current was observed, by the fall of adjacent leaves in one direction, to be stimulation at the cathode; on breaking the current, stimulation was induced at the anode, evidenced by the fall of leaves in the opposite direction. It was further demonstrated that transmission is arrested by an electrotonic block; that is, excitation cannot travel along a tissue through which a constant electric current is being maintained. These results, obtained equally with stem and petiole, go to prove that excitation is transmitted in the plant in essentially the same manner as it is in the nerve of the animal.

The remaining sections of the paper deal mainly with anatomical details. The conclusion is reached that the phloem is the tissue that conducts excitation; not the sieve-tubes, but the elongated tubular cells of which the phloem mainly consists. Moreover, evidence is adduced that a strand of these tubular cells occurs also on the inner surface of each xylem-bundle, and this strand is termed the "internal phloem." The results of anatomical observation agree with those of physiological investigation by means of the electric probe. When the probe was inserted gradually into the petiole, maximum negative galvanometric deflexion was manifested when it penetrated the external phloem and again when it reached the internal phloem.

The paper concludes with a comparative study of the pulvinus, from which it appears that the more excitable the pulvinus the more deeply does the protoplasm of its contractile cells stain with safranin; it also reduces osmic acid, indicating the presence of a readily oxidisable substance, not a fat or a lipid, which is probably concerned in developing the energy required for the active contraction of the organ.

Earthquake Investigation in the United States.

AS already mentioned in NATURE of April 25, p. 615, an act of the United States Congress was approved early this year, enacting "that the Coast and Geodetic Survey is hereby authorised to make investigations and reports in seismology, including such investigations as have been heretofore performed by the Weather Bureau." The reasons for the change and the work that it is hoped to accomplish are given in an excellent popular account (U.S. Coast and Geodetic Survey, Serial No. 304, price 10 cents) by Mr. E. Lester Jones, the director of the Survey.

In 1899, the Coast and Geodetic Survey developed a plan for the magnetic survey of the United States, and five observatories were established in places that proved to be admirably adapted for earthquake observations. Of these places—Porto Rico, Maryland, Arizona, south-east Alaska and Hawaii—three are in major earthquake zones and one near

such a zone. As in other places, it was found that the magnetic instruments recorded certain kinds of earthquake waves, and they were supplemented by seismographs which have been in action for more than twenty years. In 1906, after the Californian earthquake, the Weather Bureau installed seismographs at Chicago, Washington and Northfield (Vt.), but, after a time, it was found that seismological investigation, and especially the instrumental part, did not fit in well with the work of the Weather Bureau, nor did the Coast and Geodetic Survey feel justified in attending to seismographs merely as an adjunct to its magnetic work. Accordingly, by agreement of the Secretaries of Agriculture and Commerce, Congress was asked to enact the legislation referred to above.

In several ways, the ordinary work of the Coast and Geodetic Survey is adapted for earthquake investigations. The routine of operating magnetic

instruments, with the necessary attention to details which such precise instruments require, gives the observers the qualifications needed to get the best results from high-grade seismographs. The Survey maintains tidal stations at numerous points along the coast with continuous record by automatic gauges. Most important of all is the fact that the changes in the horizontal or vertical position of places in the central area of an earthquake can be determined only by precise triangulation and levelling. Such work by the Coast and Geodetic Survey has been in progress for three years in California, for it is understood that not only have changes occurring at the time of earthquakes to be considered, but also movements of large areas as a whole between earthquakes.

C. D.

University and Educational Intelligence.

A SUMMARY of important State Laws relating to education enacted in 1922 and 1923 has been published by the United States Bureau of Education in Bulletin 1925, No. 2. In the year 1923, laws were passed in twenty-two States prescribing instruction in the public schools in the constitution of the United States, the duties of citizenship, or "Americanism," which is defined (North Carolina) as including (a) respect for law and order, (b) character and ideals of the founders of the country, (c) duties of citizenship, (d) respect for the national anthem and the flag, (e) a standard of good-government, (f) constitution of N. Carolina, (g) constitution of the United States. In Florida, teachers and professors in State institutions were forbidden to teach atheism or agnosticism or to teach as true Darwinism or any other hypothesis that links man in blood relationship to any other form of life.

THE London County Council has again arranged numerous lectures for teachers during the winter, and a descriptive handbook has been prepared (The County Hall, Westminster Bridge, S.E.1.). The lectures scheme is now self-supporting, and last year's attendance approached 14,000. Any person engaged in teaching in London or Middlesex is eligible for admission at fees which average less than 1s a lecture; out-county teachers are admitted at fees 50 per cent higher. Among the lectures which will interest readers of NATURE are the following.—Special single lectures by Prof. J. Arthur Thomson on "Visualising in Nature Study," by Sir William Bragg on "Quartz," by Sir Sefton Branner on "Aviation in the British Empire," Dr. A. S. Russell on "Radio-activity," Prof. Leonard E. Hill on "Sunlight and Open-Air Classes," and by Mr. Richard Kerton on "Wild Life round London." Courses will be given by Prof. T. P. Nunn on science for the elementary school, by Dr. L. F. Bates on modern theories of magnetism, by Mr. J. W. Bispham on science-teaching in junior technical schools, by Prof. Cyril Burt on mental tests, and on experimental psychology and its bearing upon education. In mathematics there will be three courses dealing with the teaching of mathematics of different grades, while Prof. H. Levy is giving a course on the work of the mathematical laboratory. Geography is represented by courses on physical, regional and historical geography, on the teaching of local geography and on practical work in geography. These lectures are valuable in that they enable teachers to keep in touch with modern developments in their respective subjects.

THE City and Guilds of London Institute has issued as an addition to its report for 1924 (the

forty-fifth annual report since the incorporation of the Institute) a report to the University of London by the University's Visitor, Sir Alfred Ewing, on the research, teaching, and equipment of the City and Guilds (Engineering) College. The Visitor found much to admire and very little to criticise. His observations relate to matters of such fundamental importance, and they are supported by lucid statements of principles so generally applicable, that they deserve attentive consideration by other engineering schools. Referring to the danger, to which all engineering schools are exposed, of overloading the course with a study of technological method and detail which takes up the time and attention that should be given to matters which are far more educative and, in the long run, of greater professional importance, Sir Alfred Ewing remarks that it "tends to become more acute where a school is divided into departments which may tempt a student to specialise prematurely, and where in each department there is a lavish equipment of large-scale engineering plant." He adds, however, that the course at the City and Guilds College, where the laboratories are extraordinarily spacious and splendidly equipped, is, on the whole, well balanced. Among the novel and interesting features of the laboratory work are testing machines of a new type designed by Prof. Dalby. A large section of the laboratory is not in use at present on account of the difficulty of paying rates on it. The technological examinations conducted by the Institute in Great Britain and Ireland were held at 297 centres, and the number of candidates examined was 8578. In addition, 1326 candidates were examined in the Dominions Overseas (chiefly New Zealand) and India.

THE League of Nations (Information Section) sends us a report on the "Instruction of Children and Youth in the Existence and Aims of the League" which is to be submitted to the Sixth Assembly opening in Geneva on September 7. The report shows that the League's propaganda has led to a vast amount of activity on the part of government departments, national associations of teachers, and other national and international organisations in the preparation of special pamphlets and magazine articles, the provision of special lectures and courses of instruction, the organisation of conferences, exhibitions, schemes for awarding special diplomas and badges, inter-scholar correspondence, exchange of students and international visits, and obtaining travelling facilities and collective passports. The Sixth Assembly is to consider, *inter alia*, a proposal that the League's Committee on Intellectual Co-operation should invite all professors and teachers to collaborate by preparing and distributing to all scholastic institutions literature instructing the young in the aims of the League. The effects of all these activities in different countries will depend to a great extent on the place already held in the national system of education by instruction in the duties of citizenship and practical exercises in those duties. Where, as in the United States, these are commonly recognised as an essential part of primary education, the attempt to establish a new loyalty to the ideals of the League may find a safe foundation of patriotism on which to work, but when this foundation is lacking the results may be unfortunate. In Great Britain, at any rate, it may well be asked whether the teaching of loyalty to that older league of nations known as the British Empire should not take precedence. "The internationalism that denies the worth of patriotic preference," says Wickham Steed in the preface to his reminiscences, "is as debilitating as is unqualified scepticism in regard to philosophical or religious belief."

Early Science at Oxford.

September 9, 1684. A letter from Mr. Creech, dated from Worcester, September the 4th, was read; it gave an account of a Woman in Worcester, who, for these twenty years last past, has every Sunday had a Convulsion Fit, and at no time else, unless she puts both her feet over her threshold; which if she does, a fit certainly seizes her; the case of this woman is drawn up by ye learned Dr. Cole, Physitian at Worcester, and was communicated to severall of the physitians in Oxford about a year and a half since.

Mr. Francis Davenport's account of the Tides at Tunquin and Mr. Halley's Theory of those Tides, were read, and will be printed very suddenly.

Dr. Plot communicated an Instrument made by Mr. Bard of Fretwell, for ye better æstimating ye increase, and decrease, of ye weight of oil of vitriol exposed to ye open air: ye Doctor promises us to make use of it, and give ye Society an account of ye success

Dr. Plot also communicated an account of ye weather here at Oxon: during ye last month; and an abstract of a letter from the Reverend Dr. Thomas Smith, now at London, who says, that a Naturall History of Scotland is lately printed at Edinborough by Sir Robert Sibbald.

The Doctor further communicated to the Society that, in a visit made by himself to ye men of Siam lately come into England, he received from them a present of a black lead pen of their country, and a nut whose kernell is call'd Areka, which has a smart aromattick tast, and is said to be purgative

He understood from them, that their alphabet, and numerall figures, were ye same with those of ye Indians.

Dr. Smith shewing himself very ready to oblige ye Society, by proposing to those men of Siam any quæries which shall be sent him hence, it was offered by Mr. Bernard, that ye Doctor be desired to discourse with them on ye severall heads of Dr. Plot's sheet of enquiries

There being some discourse concerning Barometers, particularly it being affirmed, That a candle placed near ye upper and empty part of ye Tube will make ye quicksilver descend; it was proposed by Mr. Bernard, that tryall be made, whither spirit of hartshorn, applied to the top of ye Tube, will cause ye quicksilver to ascend?

Mr. President proposed that enquiry be made whether the quicksilver arises and falls in old barometers, to as many degrees, as it did in ye same barometers, when they were new? In one, which he for many years made use of, he has found it does not.

Dr. Plot presented ye Society with a peece of heavy wood from Jamaica, called *Kicongo*; 'tis of a smell like *Enula Campana*. Some Experiments will be tried on it very suddenly; and an account of them brought in to the Society.

The Doctor, having finished his discourse *de Origine Fontium*, was, at this meeting, desired by ye Society, to communicate it to them, and begin reading it the next week

The Society then tooke into consideration the enlarging of their Correspondence; for ye effecting of which, they concluded, that some attempts be made for ye settling a Correspondence in Scotland, in like manner, as it is now carried on between ye Royall Society, and that of Dublin, and this of Oxford; in order whereunto, it was ye most humble request of this Society to Mr. President to take on him ye trouble of writing to the Heads of ye Universtys in Scotland, concerning this affair.

Societies and Academies.

LONDON.

Institute of Metals (Autumn Meeting, Glasgow), September 2.—J. H. Andrew and Robert Hay. Colloidal separations in alloys. The β constituent may break down into colloidal α and colloidal γ , and upon submitting these to an electrical current, the colloid is destroyed and the crystalline phase begins to make its appearance. The ageing of duralumin may be due to the deposition of the magnesium compound in the colloidal form, when the increase in hardness would be due rather to the fineness of state of division of the separating phase than to its specific properties.—John S. Brown: The influence of the time factor on tensile tests conducted at elevated temperatures.

With non-ferrous alloys there is a critical temperature condition, above which the rate of application of the load has an important influence on the observed strength. This time factor tends to lose its effect when the rate of loading is kept below 1 ton per sq. in. per day, and this value is consequently put forward as of basic importance in such investigations.

—R. B. Deeley: Zinc-cadmium alloys. A note on their shear strengths as solders. A substitute for brazing spelter was required for the motor-cycle industry. The working temperature of the substitute solder had to be below that likely to promote coarse crystallisation of the hard-drawn steel tubing of the frame, and the melting point had to be sufficiently above the enamel stoving temperature (about 180° C) for joints made with the alloy not to fail during enamelling. Zinc-cadmium alloys in pure shear show the strongest alloy to be near the eutectic composition. This alloy is considerably stronger than tinman's solder, 8 tons/sq. in. compared with 4 tons/sq. in.—J. W. Donaldson: Thermal conductivities of industrial non-ferrous alloys. The thermal conductivities of 70:30 brass, high tensile brass or manganese bronze, Admiralty gunmetal, ordinary gunmetal, bearing phosphor bronze, white bearing metal, and monel metal are low, ranging from 0.067 for monel metal to 0.242 for 70:30 brass. Increasing the temperature increases the conductivities. The alloys of tin and copper have a lower conductivity than those of zinc and copper, while nickel lowers considerably the conductivity of an alloy containing it.—Marie L. V. Gayler: On the constitution of zinc-copper alloys containing 45 to 65 per cent. of copper. In an equilibrium diagram, no change in microstructure of alloys consisting wholly of the β constituent could be detected.

—J. L. Houghton and W. T. Griffiths: The β transformations in copper-zinc alloys. The change of resistivity with temperature was determined for some alloys containing from 46 to 63 per cent. copper. Above 55 per cent. copper the β -transformation temperature is 453° C., between 55 per cent. and 51 per cent. copper it takes place at temperatures rising from 453° C. to 470° C., with less than 51 per cent. copper the transformation temperature is 470° C. These data are opposed to the theory that this is a eutectoid transformation. The specific resistances at room temperatures were also measured after annealing just above the transformation point. The resistance falls rapidly as the copper decreases from 61 per cent. to 53.5 per cent., and less rapidly to about the 50 per cent. copper alloy; it rises steeply from this point with further decrease of copper content. Thus the two boundaries of the field at room temperature occur at 50.0 and 53.5 per cent. of copper.—C. H. M. Jenkins: The physical properties of the copper-cadmium alloys rich in cadmium. Alloys containing up to 5 per cent. of copper in the

cast, rolled and annealed states, were used. The effect of even a small addition of copper to cadmium is to cause the formation of a second constituent CuCd_2 , this increases the tensile strength and Brinell hardness and prevents the grain growth of cadmium on annealing. Additions of more than 3 per cent. of copper do not materially improve the mechanical properties of cadmium owing to the presence of too large a proportion of the brittle compound.

PARIS.

Academy of Sciences, July 20.—A. Haller and R. Cornubert: The constitution of the dimethylcyclopentanone and the dimethylcyclohexanone obtained by alkylation by means of the sodium amide method.—Nicolas Kryloff: A method based on the principle of the minimum, for the approximate integration of differential equations.—R. A. Fisher: The solution of the integral equation of V. Romanovsky.—W. Stepanoff: Some generalisations of nearly periodic functions.—Rolf Nevanlinna: A theorem of unicity relative to uniform functions in the neighbourhood of an essential singular point.—N. Lusin: The use of the diagonal of Cantor.—R. Roudaire-Miégevillé: A new grapho-mechanical determination of systems of real or imaginary solutions of algebraical equations.—J. Seigle: Tests of mild steel by combined stresses.—Marcel Peschard: The magnetisation of ferro-nickels (paramagnetic properties).—G. Athanasiu: The sensibility of actinometers with electrodes coated with silver iodide and copper oxide.—G. Bruhat and M. Pauthenier: A theoretical study of $320\text{ m}\mu$ of carbon disulphide.—R. de Malleman: The calculation of rotatory power starting with the molecular structure.—S. Pina de Rubies: The arc spectrum of scandium. The scandia was extracted by G. and P. Urbain from Madagascan thortveitite, transformed into the acetyl-acetonate and the latter purified by repeated sublimations in a vacuum at 190°C , followed by recrystallisation from absolute alcohol. A table of wave-lengths and intensities is given.—Gabriel A. Rousseau: Method for instantaneous photography in colour. Three films are superposed: the first receives a slow ordinary emulsion, the second an emulsion sensitive to the yellow and green, and the third an emulsion sensitive to the yellow and red. Details of the preparation of the sensitised films are given. The photograph is taken without a screen, working as with an ordinary plate.—Adolphe Lepape: The radioactivity of some cold springs in the Bagnères-de-Luchon region and on its origin.—Mlle. Germaine Cauquil: Study on viscosity and surface tension during esterification.—Pariselle and Laude: The magnesia carried down by alumina in ammoniacal media. The presence of a large excess of ammonium chloride prevents co-precipitation of magnesia with aluminium hydroxide.—Pierre Bedos: A new racemic menthone and the two corresponding stereoisomeric menthols.—R. Locquin and R. Heilmann: The decomposition of the pyrazolines by spontaneous oxidation. The spontaneous oxidation of pyrazolines by air is complex and gives either a saturated or an unsaturated ketone, together with basic substances of high boiling point, so far not identified.—E. E. Blaise and Mlle. M. Montagne: The transformation of the dialkylcyclohexenones into dialkylbenzenes. Methyl-ethylcyclohexenone heated in a sealed tube on the water bath with a saturated aqueous solution of hydrobromic acid gives *o*-methylethylbenzene. The reaction appears to be of a new type.—I. Pouget and D. Chouchak: The radioactive mineral waters of Guergour, Algeria.—Mlle. H. Popovici: The formation of essential oils.—Raoul Combes: Does light exert a direct action on the decomposition of chlorophyll in

leaves in the autumn? The results of the experiments described are not in agreement with Wiesner's hypothesis, and light does not appear to be a direct cause of the disappearance of chlorophyll from leaves in the autumn.—André Mayer and L. Plantefol: The equilibrium of the cellular constituents and form of oxidations of the cell. Imbibition and respiratory types in reviviscent plants.—H. Colin and A. Grand-sire: The mineralisation of green leaves and of chlorotic leaves.—P. R. Bohn: The presence of crystals of calcium oxalate at the surface of certain Caryophyllaceæ.—Kühner: The development of *Lentinus tigrinus*.—Emile Saillard: The method of Clerget. Coefficients of inversion. Inversion at the ordinary temperature for 28 hours, or at 70°C (11 minutes) gave the same results. The inversion coefficient varies slightly with the concentration of the saccharose: figures are given for coefficients of solutions from 4 to 16 per cent. of saccharose.—Ch. Brioux and J. Pien: The use of the quinhydrone electrode for the determination of the p_H of soils. This method is advantageous from the point of view of rapidity and simplicity, but there are divergences between the results obtained by the quinhydrone and hydrogen electrodes at present unexplained.—M. and Mme A. Chauchard: The law of excitability of the electrical apparatus of *Torpedo marmorata*.—A. Rochon-Duvigneaud, E. Bourdelle, and J. Dubar: An attempt at the determination of the anatomical binocular visual field of the horse.—F. Viès and A. de Coulon: Relations between the experimental displacement of the muscular isoelectric points and the evolution of grafted tumours.—L. Hugounenq and J. Loiseleur: The superposition of the phenomena of dissociation and elective adsorption in the proteolytic diastases.—E. Kayser and H. Delaval: Radioactivity, nitrogen fixers and alcoholic yeasts. In an earlier communication it was proved that the addition of a radioactive mineral to the ordinary nutritive medium stimulated the action of Azobacter, and the increase varied with the strain of the organism. These results are now supplemented by varying the proportion of the radioactive mineral, by ascertaining the influence of repeated use, and by determining the ratios between sugar used up and nitrogen combined. The effect of the radioactive mineral on alcoholic fermentation has also been studied.—Jean Bathellier: The period of the determination of the castes in *Eutermes matangensis*.—Ch. Champy: The disharmony of the secondary sexual characters and the proportionality of the sexual glands in insects.—G. Ramon: The production of antitoxins.—F. Diénert: Contribution to the study of activated sludge.—Georges Bourguignon: The physio-pathological signification of Babinski's test.—C. Levaditi, A. Girard, and S. Nicolau: The treponemical action of gold and platinum.—Georges Truffaut and N. Bessonoff: The predominance of the activity of anaerobic nitrogen fixers in the soil.

CALCUTTA.

Asiatic Society of Bengal, August 3.—H. L. Chhibber: Microscopic study of the old copper slags at Amba Mata and Kumbaria, Danta State, N. Gujarat, India. The sites are two old metallurgical centres more than six hundred years old. The slags are mostly the remains of low grade minerals of the oxidised zone; no great depth below the surface was worked.—N. G. Mazumdar: Dacca image inscription of the reign of Lakshmanasena. Iconographically this is an important image, as representing an otherwise unknown type of Chandī.—B. S. Guha: Preliminary report on the anthropometry of the Khasis. Measurements were made of inhabitants of Cherapunji and neighbouring villages. Special attention was given to the measurements of

the face; there is difficulty in determining the shade of colour of the skin of brown people.—Hem Chandra Das-Gupta: Palaeontological notes on the Panchet beds at Deoli, near Asansol. Descriptions of three specimens: (1) the carapace of a brachyurous crab (?); (2) a stegocephalian cranium; (3) a reptilian coracoid. The second specimen is tentatively identified as belonging to *Pachygona incurvata*, Huxley, the third specimen, similarly, to *Epicampodon* (*Ankistrodon*) *indicum*, Huxley. The first specimen differs from the only two described genera of Triassic brachyurous crabs.—Sukumar Sen: Notes on the employ of the cases in the Kāṭhaka-saṃhitā. An analysis of the use of the cases as exhibited in Leopold von Schroeder's edition, published from 1900 to 1910, shows a marked difference in language and idiom as compared with other Vedic prose texts.

MELBOURNE.

Royal Society of Victoria, July 16.—Gerald F. Hill: Termites from the Ellice Group. The only species of termite hitherto recorded from these islands has been confused with an American species until recently supposed to have been introduced into Hawaii. The species is identical, however, with an imperfectly known Samoan insect—*Calotermes samoanus* Holmgr—and not with any described Hawaiian or American form. *Proterhinotermes inopinatus* Silv., hitherto known only from Samoa, is now recorded from the Ellice Group. Both species are destructive to coconut palms.—C. E. Eddy: The *L* absorption limits of lutecium, ytterbium, erbium, and terbium. The *L* series critical absorption wave-lengths were measured relative to tungsten *L* lines as standards. A metal X-ray tube, with a thin window, and capable of being operated at 30 kilovolts and 30 milliamperes, was constructed, and used in conjunction with a low pressure spectrometer. The values of the critical absorption wave-lengths were as follows:

	<i>L_I</i>	<i>L_{II}</i>	<i>L_{III}</i>
Lutecium . . .	1136.21 X.U.	1194.0 X.U.	1337.5 X.U.
Ytterbium . . .	1176.4	1238.14	1382.64
Erbium . . .	1265.5	1335.60	1479.19
Terbium . . .	1417.0	1499.4	1644.2

—W. J. Harris: Victorian graptolites (new series), Pt. 2. Four graptolites are described, three being new species, and one of these representative of a new family. Atopograptidae (*fam. nov.*)—a biserial form with thecae with extroverted apertures; represented by *A. woodwardi*, *nov.*, from Bendigo East. *Didymograptus nodosus*, *sp. nov.*, and *Cardiograptus crawfordi*, *sp. nov.*, from Bendigo East and Gisborne (Victoria). These three species are from Upper Darriwil beds, near the top of the Lower Ordovician.—W. M. Bale: Further notes on Australian hydroids, V. This paper describes *Sertularia nana* and *S. gracillima* new species, and gives a detailed account of *S. furcata* Trask, a common Californian species recorded doubtfully as Australian. A *Sertularella*, originally referred to *S. polyzonias*, is now described as *S. peregrina* n. sp. It is most nearly related to *S. mediterranea* Hartlaub. *Plumularia delicatula* Bale is given a new name—*P. wilsoni*—on account of the priority of *P. delicatula* Busk (an Aglaophenia). A variety of *Aglaophenia divaricata* Busk, formerly referred doubtfully to *A. acanthocarpa* Allman, is named var. *briggsi*.—Irene Crospin: The geology of Green Gully, Keilor, with special reference to the fossiliferous deposits. Green Gully is near the Keilor township, ten miles from Melbourne. The rocks consist of a succession

of Cainozoic sediments overlying the older basalt which rests on the Silurian bed-rock. The lowest of these Cainozoic sediments is a moderately deep-water limestone which passes into a fossiliferous ferruginous rock, both of which are of Miocene (Janjukian) age. The limestone is characterised by a rich growth of calcareous alga (*Lithothamnium*) and by the abundance of the discoidal tests of several species of *Lepidocyclina*. The ferruginous bed contains a large assemblage of molluscan fossils, mainly in the form of casts, as well as some corals, which show close relationship with the Janjukian fauna of Table Cape, Tasmania, some species being restricted to the two localities.—Frederick Chapman: Geological notes on Neumerella and the section from Bairnsdale to Orbost. Fossils are of Miocene (Janjukian) age and were collected at Neumerella during the construction of the Bairnsdale to Orbost line. 150 species of fossils are recorded and notable additions made to the lists of fossil fishes, ostracoda, mollusca, polyzoa, and foraminifera. The fossil bands are seen in the cuttings, with remains of cetaceans and sharks' teeth; there are intercalated marly limestone layers, and evidence of local crumpling and faulting in the Janjukian. Large volutes and Nautilus frequently occur in the yellow marls as casts, and many are encrusted with a crystalline coating of calcite, probably representing the dissolved shell.

ROME.

Royal Academy of the Lincei, June 21.—B. Grassi: Contribution to the study of the biology of *Anopheles superpictus*.—B. Longo and A. Cesaris-Demel: The possibility of anaphylactic sensitisation in vegetable organisms.—S. Saks: Integration of the polynomials of Stieltjes.—Bruno Finzi: The motion of the boomerang.—Luigi Carnera: The new Washington catalogue of fundamental stars and the Berlin catalogue of circumpolar stars.—D. Pacini: Observations on the vertical air-earth current.—E. Fermi and F. Rasetti: Effect of an alternating magnetic field on the polarisation of resonance light.—E. Persico: Amplitude of the oscillations produced by a three-electrode lamp.—L. de Caro: Surface tensions of gelatin solutions of different hydrogen-ion concentrations.—E. Clerici: The diffusion of certain microscopic organisms of the rocks accompanying the Roman volcanic tufas.—Silvio Ranzi: The organ of sense derived from the first epibranchial placoid of Selacei.

Diary of Societies.

WEDNESDAY, THURSDAY, FRIDAY, SEPTEMBER 9, 10, 11.

IRON AND STEEL INSTITUTE (Birmingham Meeting) (at the University, Edmund Street, Birmingham).—J. H. Andrew and R. Higgins: The Dilatation of Cast Irons during Repeated Heating and Cooling.—M. L. Becker: Equilibrium at High Temperatures in the Iron-Carbon-Silicon System.—D. F. Campbell: High Frequency Induction Furnaces.—E. D. Campbell and J. F. Ross: The Chromium-Iron Equilibrium in Carbides recovered from Annealed 2.23 per cent. Chrome Steels.—A. L. Curtis: Steel Moulding Sands and their Behaviour under High Temperatures.—Prof. C. A. Edwards and L. B. Pfeil: The Tensile Properties of Single Iron Crystals and the Influence of Crystal Size upon the Tensile Properties of Iron.—Dr. C. F. Elam: The Orientation of Crystals produced by heating Strained Iron.—Dr. J. Newton Friend and W. E. Thoinycroft: Ancient Iron from Richborough and Folkestone.—R. H. Gieaves and J. A. Jones: The Effect of Temperature on the Behaviour of Iron and Steel in the Notched Bar Impact Test.—L. Grenet: Notes on the Iron-Nickel and Iron-Cobalt Equilibrium Diagrams.—H. Kamura: Reduction of Iron Ores by Hydrogen.—J. L. Keenan: Blast Furnace Practice in India, with special reference to Economy in Coke Consumption.—W. R. Martin: The Davis Steel Wheel and its Manufacture in England.—J. A. Mathews: Retained Austenite.—H. Fiodin: A New Direct Process.—J. H. Partridge: The Magnetic and Electrical Properties of Cast Iron.—A. Sauveur and V. N. Krivobok: Dendritic Segregation in Iron-Carbon Alloys.—A. Sauveur and D. C. Lee: The Influence of Strain and of Heat on the Hardness of Iron and Steel.



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The Worth of Knowledge.

*O fret not after knowledge !—I have none,
And yet my song comes native with the warmth.
O fret not after knowledge !—I have none,
And yet the Evening listens.*

KEATS.

IN the course of his presidential address to the Education Section of the British Association at the recent Southampton meeting, Mr. W. W. Vaughan, headmaster of Rugby School, remarked that an agricultural labourer who had left school at thirteen years of age is often a better-educated man, in the best sense of knowledge, than a city clerk or other black-coated worker who had passed through a secondary school course before entering office life. Those who are familiar with the countryside and farm labourers know that much truth is contained in Mr. Vaughan's observation, but they know also that it is a dangerous doctrine to preach because of the excuse it gives to farmers and parents to secure the release of children from school at the earliest possible age in order to put them at work in the field. It is easy to suggest that a child who leaves school for outdoor work at ten or twelve years of age may be learning more than he would in a village classroom, but this is the kind of reasoning that leads to the exploitation of child-labour; and, in Great Britain at any rate, the State has rightly decided that every child without exception, whether in country or town, must now remain at school until at least the age of fourteen years has been reached.

There are, of course, many social reasons for this necessary condition, and among them is the value of discipline. Knowledge itself, especially that often contemptuously called "book-learning," may, as Keats expressed in the lines from his sonnet on "The Thrush," quoted above, be of little actual worth as a means of gaining or giving delight to life, yet, like the gift of mercy, it can be twice blessed if rightly used. There is one joy in seeking after knowledge and another in arousing interest in others in the beauty and promise of the new world revealed. What is worth having is worth sharing, and it is because of this conviction that we continually urge support and encouragement to effort made to create and foster wide interest in scientific achievement.

This is one of the objects of the British Association, and we believe that the annual meetings do much to fulfil their purpose in this respect through the publication in the newspapers of summaries of the presidential addresses, lectures and selected papers. It is, however, in no captious spirit that we suggest that much more remains to be done if the service of science in modern life is to be understood through the meetings

of the Association. In the first place, there should be no misapprehension as to the constitutions of the audiences for which the president's address and the addresses of the sectional presidents are intended. Members of the lay public are invited to join the Association, but the presidential addresses are almost invariably unintelligible to them; and so are most of the papers. There are no doubt people like the lady who said she did not understand a scientific lecture she had attended, yet she liked the sound of it, but it is scarcely the function of the Association to titillate the ears of passive listeners.

We are of the opinion, however, that the addresses of the president and of the sectional presidents are better read than heard, and on this account we are glad that they are again available in volume form.¹ The first part of Prof. Lamb's presidential address deals with the absorbing topic of the nature and purpose of science in general, and we hope that it will be widely read and discussed, for such remarks, so admirable in form and substance, not only provide scientific workers with justification for the faith which is in them, but also tend to "clear the air" of any lingering feeling of hostility between them and those whose labours are purely humanistic. The addresses of the sectional presidents cover a very wide field, almost the whole gamut of the sciences. Many of them deal mainly or exclusively with recent advances in specialised departments; others, like those on engineering and anthropology, are throughout historical; and again others, like the addresses to the educational and economic sections, discuss problems which are of perennial interest. In every case the standard attained is high, the contribution notable, and if we have any adverse criticism to make, it is that, from the point of view of the lay reader, too many of the addresses are concerned with specialised and recondite topics to the exclusion or subordination of matters which are of more obvious interest and importance; in other words, they may appear dull to the average man.

The meetings of the British Association are most useful in bringing together workers in many branches of science. In recent years the institution of joint discussions on border-line subjects has increased their utility; and of late there has been a noticeable levelling-up in the scientific value of the papers presented; all of which is to the good. The problem, therefore, consists in realising a harmonious balance between the requirements of the specialist and those of the lay public. It will, we believe, be generally admitted that addresses and papers should not, as a rule, resemble those which are given at ordinary meetings of specialised societies:

¹ The Advancement of Science, 1925. London: British Association, Burlington House, W.1. Price 6s.

the treatment should be broader and more in touch with human welfare—not necessarily material welfare.

From this point of view, some of the addresses and papers contributed to the recent meeting are open to criticism. About one-half of the addresses printed in the annual volume are obviously written by the specialist for the specialist. Although subjects relating to education (upon which nearly every other man claims to speak with authority) and to economics lend themselves more readily to popular treatment than others it has been repeatedly shown that even in very recondite branches of science it is possible to introduce matter which appeals to the man of average intelligence and education. As examples in point, we may refer to the addresses given this year to the physiological and psychological sections. The physiology of muscular exertion and the theory of intelligence do not at first sight appear inviting topics to the non-specialist, but the manner of treatment as well as the matter treated secured in these cases extended notices in the daily papers. Prof. Parks' address on the cultural aspects of geology was also framed in a manner likely to appeal to a wide audience. We do not, of course, wish to plead for a stereotyped form of presentation, and we are well aware of the great difficulties inherent in popular exposition, but we do urge that the interests of the Association would be better served if greater use were made of its unique opportunities for securing the infiltration of scientific learning into all classes of the community.

Possibly the specialisation of scientific work must prevent the proceedings of the sections from making more than a sectional appeal. If this be so, then the Association must be regarded chiefly as a professional organisation, like the British Medical Association and similar bodies, neither desiring nor expecting members of the general public to attend its meetings. Even then, we urge that more serious attempts should be made to improve both literary and oral exposition in presenting papers. We plead for a style of composition and exposition suitable at least for a general scientific audience, even if the lay public is left out of account. It is surely a reflection upon scientific training that so few who represent it are able to address a public or any other audience in a manner which will command attention or stimulate interest.

A few lecturers of this kind are available, and the Association does its best to secure them for the public lectures delivered to citizens, and to children, at each annual meeting. These lectures are not intended for members of the Association, and arrangements for them are in the hands of the Local Executive Committee. In these days of many kinds of entertainment and obtrusive advertisement, it is obvious that

wide publicity should be given to the citizens' lectures if good attendances are to be secured. This was not done at Southampton, with the result that the attendances at both these lectures and the children's lecture were far smaller than the lecturers or their subjects merited. Any good lecture agent would have secured large audiences for these lectures if they had been business undertakings, but as they were not, very few people in the town or neighbourhood were aware of them. This is not the way to further the purpose of the Association "to obtain more general attention for the objects of science."

The History of Telephony.

The History of the Telephone in the United Kingdom.

By F. G. C. Baldwin. Pp. xxvi+728+75 plates. (London: Chapman and Hall, Ltd., 1925.) 42s. net.

THIS large book on the history of the telephone in the United Kingdom gathers together in a single volume an immense amount of valuable historical research on the development in Great Britain of one of the epoch-making inventions of electrical science. The invention of the magneto-electric telephone and the reproduction by it of articulate speech at a distance is a striking example of the solution of a technical problem, long recognised as possible of solution, attacked by several inventors with very little success, yet finally accomplished by a stroke of genius in the very simplest manner.

The speaking telephone, far more than many other electrical inventions, may be credited to a single inventor, in that Alexander Graham Bell was the first to discover a method, imperfect though it was, of translating the changes of air pressure constituting speech wave sounds into corresponding changes of electric currents in a line wire, and the conversion of them back into sound waves at the receiving end. This use of what was then called an undulatory current in a circuit never completely opened made possible the electric transmission of speech as compared with the transmission of mere musical sounds. Like many other inventions, Bell's success came as a kind of accident in the manipulation of an appliance called a harmonic telegraph which was not originally intended or hoped to function as a speaking telephone. Mr. Baldwin sketches in brief outline in his first chapter the stages by which Bell was thus led to success.

The remarkable thing about the Bell magneto telephone, with its steel diaphragm, having such a limited number of modes of vibration, is that it should be able to transmit intelligible speech sounds at all. It is probable that a large part of its success depends not so much upon its own intrinsic powers as upon the wonderful ability of the human ear to guess from a mere

suggestion of a speech sound the intellectual meaning which that sound is intended to convey. The true air wave-form, with its complicated outline, is in fact very imperfectly reproduced by the telephone receiver diaphragm, but a mere hint enables the trained ear to interpret it.

Bell's invention, though effective as a receiver, was a very ineffective device as a transmitter, and if it had not been supplemented by the invention by Edison of the carbon transmitter, and by Hughes of the microphone, it is highly improbable that it would have fructified into practical utility or even passed beyond the stage of a scientific curiosity. The combination, however, of the variable resistance or microphonic carbon transmitter and the induction coil as a means of translating sound-wave motion into electric current variation, together with Bell's magneto-receiver for effecting the reverse transformation, gave a completely practical and simple solution of the telephone problem.

In his second chapter Mr. Baldwin describes the early operations and subsequent union of the Bell and Edison inventions and the early stages of invention in connexion with the evolution of a telephone exchange. But for this latter conception, which originated in America, the use by the public of the electric telephone would have been extremely limited. The pioneer work of the original Bell and Edison Telephone Companies in London, in establishing rudimentary telephone exchanges, is described by Mr. Baldwin in his second chapter, and also the story of the initial litigation between the Companies before the United Telephone Company was formed.

Chapter iii. opens with an account of the important litigation started by the Crown against the United Telephone Company to enforce against it the rights gained through the Telegraph Acts of 1863, 1868, 1869, under which the State purchased for about 10 million sterling the business of the pioneer electric telegraph companies. These original telegraph companies conducted their operations with diverse kinds of signalling instruments, and before long there arose a movement for "nationalising," as it is now called, the new methods of intercommunication. In order to prevent the Government monopoly being infringed by the possible invention of new types of electric telegraph, the Acts were drawn in such general terms that, when the telephone inventions made it possible to establish commercial exchanges worked for the convenience of "subscribers," the question was before long raised by Post Office officials, alarmed about their monopoly, whether the telephone was a telegraph within the meaning of the Acts.

The case was tried by Mr. Baron Pollock and Mr. Justice Stephen in November 1880 and decided against

the Company. Unfortunately, the case was never taken to the Court of Appeal or to the House of Lords for confirmation or reversal. The directors of the Telephone Company, doubtful of the issue and perhaps reluctant to dissipate their available funds on further litigation, accepted a proposal of the Post Office that they should bow to the decision of the Court of First Instance and take a licence from the G.P.O. for a term of years, and the payment of a royalty of ten per cent. of their gross receipts from all exchange business carried on within five miles of the General Post Office, London. Thus it came to pass that the fetters of State control were riveted on the limbs of the new industry; and in the following thirty years the General Post Office was able to extract from the telephone more than a million sterling in the form of royalties, for which the State had given no equivalent of actual value.

The important question, from the point of view of the general public, is whether it is to the advantage of the community that a business so technical, and involving the necessity for so much invention and scientific knowledge, should be under the control of the State at all. Arguments can be given for and against the contention. Government departments certainly do not provide a congenial soil in which enterprise, invention, or economical commercial progress can flourish. No young man entering a Government department finds that originality or initiative is encouraged or that it tends to fame and fortune for himself; in short, it does not pay, and hence he soon settles down to a steady but slow-going officialism. Moreover, Government departments are subject to the changes of policy incidental to successive administrations. Thus it has come to pass that succeeding governments in Great Britain have played with the telephone as a cat plays with a mouse. The dual control, partly by the G.P.O. and partly by a limited company, was for years disastrous to progress.

The history of the telephone in Great Britain is therefore in great part a revelation of Government ineptitude, and supplies solid reasons against that nationalisation of technical industries with which present-day socialists are so enamoured. It is sufficiently suggestive that none of the great inventions in connexion with telephony have originated with British Government officials. They did not invent the telephone itself, or originate the telephone exchange, or the dry core cable, loading coil, uniformly loaded cable, phantom circuit, automatic telephone exchange, or the thermionic telephone repeater. All these important inventions originated with private inventors and came to us mostly from the United States, where the telephone is not under Government control but is a private enterprise. Furthermore, the ideas of scientific men such as

the late Mr. Oliver Heaviside or Prof. Silvanus Thompson, who suggested improvements, were not followed up but even resisted by official electricians, and telephonic invention in Great Britain languished accordingly.

Returning, then, to Mr. Baldwin's book, we find that in the following twenty chapters he gives us an excellent account of the development of the great inventions which have been enumerated above. The gradual evolution of the telephone switchboard is illustrated by numerous valuable diagrams, and the replacement of the human element in it by the fully automatic exchange is outlined. The completely automatic telephone exchange by which, without any human intervention, a subscriber calls up another, finds out if he is already engaged, if not, converses with him, and finally switches himself out, is one of the most marvellous pieces of mechanism which the human mind has ever devised. Its elaboration has been due to many clever brains directed to a surpassingly difficult problem. The G.P.O. has now established in Great Britain a considerable number (about 25) of these automatic exchanges on various systems.

In the chapter on long-distance transmission, Mr. Baldwin only devotes a paragraph or two to another invention of cardinal importance, namely, the thermionic repeater, which has enabled a vast extension of telephonic range to be obtained. Suffice it to say that telephone electric currents are weakened by travelling along aerial lines or in cables. But a device called a thermionic repeater, which is a development of the thermionic valve invented by the present reviewer, is employed to reinvigorate these currents and send them on a farther stage with fresh energy. The importance of this invention is that it enables wires of smaller section, and therefore cheaper, to be employed. If the trunk telephone lines of Great Britain had to be relaid, it would be possible to save hundreds of thousands of pounds in mere cost of copper.

Taking the volume as a whole, we can say that Mr. Baldwin has given us a very readable and interesting history of the telephone in Great Britain. The book contains a large number of illustrations showing the development of various appliances, whilst much useful information in the form of tabular statistics is contained in the appendices. A good index completes a book which will certainly be highly appreciated by all telephone men and those who have to explore the history of any part of the subject. Lastly, a short introduction by Mr. Frank Gill, who was for eleven years engineer-in-chief of the National Telephone Company, and intimately acquainted with the history as well as technique of the subject, gives the reader an assurance of the trustworthy character of the history so well presented.

J. A. FLEMING.

The Contact Process for Oleum Manufacture.

The Manufacture of Sulphuric Acid (Contact Process).

By F. D. Miles. ("The Manufacture of Acids and Alkalis," by Prof. George Lunge. Completely revised and rewritten under the editorship of Dr. A. C. Cumming. Vol. 4.) Pp. xv+427. (London and Edinburgh: Gurney and Jackson, 1925.) 36s net

IN the realm of pure chemistry, few better examples than the chemical change between sulphur dioxide and oxygen can be selected to illustrate the general principles involved in gas reactions, whilst its value in the elucidation of the mysterious influences at work in the field of catalysis cannot be overestimated. The fundamental features of the contact process, as we now know it, were first described by Peregrine Phillips, a vinegar manufacturer of Bristol, in his patent of 1831, and to him belongs the credit of making the original scientific discovery and of realising its commercial possibilities. Nevertheless, no practical success had been attained when, in 1868 to 1872, the synthetic production of alizarin removed one of the chief reasons for this slow development—the absence of a market for fuming sulphuric acid.

At this time the sole maker of fuming acid was Baron Stark in Bohemia, the process used being substantially that of Basil Valentine (born 1394)—the decomposition of ferric sulphate obtained from "copperas-slate." No wonder that chemists turned their attention to the production of fuming acid in other places and by other methods. The publication in 1875 of a paper by Clemens Winkler, professor in the School of Mining at Freiberg, marked the beginning of most important developments. He recommended platinised asbestos as the catalyst in preference to platinised pumice or porcelain, and, in order to obtain the best results, postulated the necessity for having the sulphur dioxide and oxygen present in the stoichiometric ratio necessary for acid formation. The fact that for many years the latter statement was accepted and quoted by all classes of chemists shows how little attention the Law of Mass Action, enunciated by Guldberg and Waage in 1867, was receiving in 1875. Any chemist acquainted with this law could have shown the error in Winkler's conclusions by pointing to the equation of the reaction. Almost on the same day that Winkler sent in his manuscript, an application by W. S. Squire was lodged for a British patent, embodying the joint invention of Squire and Messel. The process was established at Silvertown and produced several tons of trioxide per week. The loss of activity of the catalyst, due to its accumulating such im-

purities as flue dust, was first noted by these workers, but its sensitiveness to specific poisons such as small traces of arsenic was not known until many years later.

In 1901 Knietzsch gave his famous lecture to the German Chemical Society, in which he described some of the work which had been carried out in the laboratories and on the plant of the Badische Company.

"This discourse," says Mr Miles, "in spite of defects and notwithstanding its many omissions, is still the most important ever recorded on the scientific and technical aspects of the oxidation of sulphur dioxide. Not only had Knietzsch and his collaborators examined the behaviour of platinum and other catalysts under various conditions of temperature and rate of flow of gas and supplied much-needed information about the physical properties of fuming acid and sulphur trioxide and their action on iron and steel; they had also found solutions of all the technical problems which had made difficult the use of pyrites burner-gases, abandoned the theory of Winkler, arrived at the unexpected conclusion that contact vessels require cooling and not heating, and had in general rendered the contact process so successful that it could henceforward not only produce fuming acid cheaply but actually compete with the chamber process for ordinary concentrated sulphuric acid."

Yet, prior to the War, the number of plants manufacturing oleum in Great Britain could be counted on the fingers of one hand. With the outbreak of war, a large supply of fuming acid became an urgent necessity, and the existing sources were quickly supplemented by many plants of great size and varying design.

Such are some of the main points in the fascinating history of the manufacture of oleum with which Mr. Miles begins his excellent book on the contact process. A survey of these facts fully supports the author's contention that the contact process is one of the foremost achievements of technical chemists, for undoubtedly the many difficulties that arose in the course of the pioneer work were solved more or less empirically by dint of hard work, the running of careful trials, and the gradual accumulation of data. However, Mr. Miles is optimistic and appreciative of the results which can and should accrue from the linking up of purely scientific and technical discovery, for, as he says, "the barriers dividing knowledge are broken down and we may hope to have in regard to the contact process in both technical and scientific aspects a body of information which from every point of view is equal to that applying to any other chemical change."

With the general treatment of the subject no one who peruses this volume can fail to be impressed. The author mentions as one of his aims the avoidance of a too sharp distinction between the technical and scientific aspects of the subject. In this respect he has been exceptionally successful, attaining an almost

perfect blending of the theoretical and practical considerations. How complex and intriguing are the numerous factors to be considered in the formation of the trioxide and its absorption may be gauged from the chapters on the properties of sulphur trioxide and oleum, gas equilibrium and velocity of reaction, catalysis and contact mass, gas purification and absorption of the trioxide. All these phases are dealt with in a lucid and authoritative manner, interposed with valuable suggestions for future research and development. The last three chapters in the volume describe Grillo-Schröder plants and the Tentelew and Mannheim processes, and contain important information of practical significance. Replete with excellent illustrations and nomographic charts, this volume is in every respect a noteworthy production, fully maintaining the great traditions which will always be associated with Dr. Lunge's treatises. - W. W.

British Scientific and Technical Books.

A Catalogue of British Scientific and Technical Books: Covering every Branch of Science and Technology, carefully Classified and Indexed. New edition, entirely revised and enlarged. Pp. xxii + 489 (London: British Science Guild; A. and F. Denny, Ltd., 1925) 12s. 6d net.

THE British Science Guild performed in 1921 an extremely useful public service in issuing a catalogue of British scientific and technical books. By donations from interested bodies and a number of publishers, and with the aid of what must have been a considerable amount of voluntary labour, the Guild has found it possible to issue a new edition without undue drain upon its own slender resources, and the result is eminently one upon which it may be congratulated.

In this edition the terms "scientific" and "technical" and the term "book" have been broadly interpreted, with the result that it contains more than 9500 titles, an increase of nearly 50 per cent. on the first edition. The entries are grouped into classes corresponding with the main and recognised divisions of scientific work, each division being arranged in sections on a subject basis, the entries in each section being in alphabetical order of authors. It is easier to criticise such a classification than to suggest an improvement, and it is hoped that the newly formed Association of Special Libraries and Information Bureaux will be able to render assistance in such matters as this. Undue dependence on the main classification is avoided by excellent author and subject indexes, but an illustration of the classification difficulty is provided, for example, by Prof. Burstall's "Energy Diagram for Gas," which is readily traceable through the author

index, but is not referred to in the subject index except under "Thermodynamics." In the body of the book the entry is made in the section on General Physics, Section ii.d, Gases, whereas its place is preferably under Mechanical Engineering, Section xviii., Internal Combustion Engines. It is also surprising to find Dr. Aston's "Isotopes" grouped in Chemistry, Section v.b, Physical Chemistry, and not referred to at all in the section on physics. It is placed consistently with the scheme of classification, but this tends to be a Procrustean bed to which the books have to be fitted. The grouping of the metallurgical section illustrates the main difficulty of making mutually exclusive sections when one section relates to materials (iron and steel, non-ferrous metals), while other sections relate to processes and methods (heat treatment, foundry practice, etc.). Close inspection of several of the main sections shows that nothing has been omitted.

It is, of course, impossible for the inexperienced student to dispense with the advice of a specialist in utilising an uncritical or unannotated collection, but this volume illustrates in an admirable way what British material is available, and it will be found constantly useful in both general libraries and the ever-increasing number of specialised technical libraries all over the country. In view also of the high reputation of British books abroad, it may well act as very valuable propaganda on behalf of British scientific literature.

Palæolithic Art.

Les Combarelles aux Eyzies (Dordogne). Par Dr. L. Capitan, l'Abbé H. Breuil, et D. Peyrony. (Institut de Paléontologie humaine: Peintures et gravures murales des cavernes paléolithiques.) Pp. iv + 192 + 58 planches. (Paris: Masson et Cie, 1924.) 200 francs.

THIS superbly illustrated volume, recording the palæolithic art of the cave of Combarelles, is the latest of the well-known series of works which started under the auspices of the late Prince of Monaco with "Altamira" in 1906 and continued with "Font de Gaume," "Les Cavernes de la région Cantabrique," and so on. These monographs have finally and for all time presented the palæolithic art of France and Spain to the student of prehistory, enabling him to do his work without having always to be visiting out-of-the-way localities and difficult caves.

More even than this has been accomplished, however, for in the texts will be found careful accounts of the systematic work done in the caves themselves, where the significance of every superposition of drawings was noted; also comparisons with outside matter are included. For example, in the volume under review, the chapters on the types of horse figured at Com-

bareilles and their relationships with the various breeds surviving to-day will not only be read with interest by prehistorians but will also be equally appreciated by the zoologist. The virgin ground broken long ago by Piette, Munro and Cossar Ewart has here yielded a rich harvest.

The cave of Combarelles is one of the most important palæolithic temples in the Dordogne. Although the art is nearly all engraved, there being scarcely any paintings, the beauty of the drawings and the skill employed has rarely been surpassed elsewhere. The animals figured include: horse (in large numbers), mammoth, reindeer, bison, ibex, bear, tiger, rhinoceros, fox, wild-ass, humans (sometimes masked), signs and so on. The age of most of this art is adjudged to be Lower Magdalenian—that is, a Magdalenian before the appearance of the barbed harpoon.

The present volume opens with an account of the discovery of the art and the situation of the cave, and this is followed by a description of finds from sites nearby, as well as an account of one or two objects from Combarelles itself. An inventory of the art on the walls and ceiling of the cave follows; the work concludes with important comparative chapters on the occurrence of the various species of animals and the figures of humans found, and a short discussion as to the age of the ensemble.

It is the plates, however, which naturally first attract the student. Even those of us who knew and had studied Breuil's tracings and photographs, both in the study and on the spot, will be delighted with the results appearing here. It was no mean feat for Breuil and his photographer to have worked for months on end in that most awkward of tunnels. Besides the clear, distinct figures there are numbers of intricate panels representing a series of complicated palimpsests. Although Dr. Capitan and M. Peyrony have done their part, to the Abbé Breuil remained by far the largest bulk of the work in the cave as well as the actual writing and preparing for press.

A monograph of high scientific importance like "Les Combarelles" ought to make our English publishers and printers pause and think. The price (200 fr.) is not excessive, and it is grievous to remember that no work of this standard could ever be produced in England at even triple the price. Once more is the Institut de Paléontologie humaine to be congratulated, and it is only to be hoped that further volumes will be soon appearing, giving prehistorians some more of that mass of unpublished material Breuil possesses. Perhaps next time there may appear an account of that equally important and still less known Spanish rock shelter art (Spanish group III.) belonging to the Late Neolithic and Copper ages.

M. C. BURKITT.

Our Bookshelf.

The Physical Chemistry of Igneous Rock Formation: a General Discussion held by the Faraday Society, the Geological Society, and the Mineralogical Society, October 1924. Pp. 411-501. (London: The Faraday Society, 1925.) 6s. 6d. net.

THE discussion on this subject arranged by the Faraday Society excited great interest, and the collected papers contain much that is of value. Whilst most of the speakers dealt with heterogeneous equilibria, and particularly with the crystallisation of minerals from magmas, one rather elaborate memoir on homogeneous equilibria was communicated by Prof. Niggli, of Zürich, in which certain considerations relating to the formation and decomposition of compounds in solution are applied to rock provinces of the Pacific, Mediterranean, and Atlantic types, a diagram being used to indicate the relationships, in such a way as to point to the differentiations which may be expected to occur during cooling.

Another question which recurs frequently in the discussion is that of the influence of volatile constituents on crystallisation. The possibility that pressure gradients as well as temperature gradients may be important is suggested by W. H. Goodchild and supported by G. W. Tyrrell, and the presence of volatile constituents is also invoked to explain the formation of alkaline rocks. Since experiments on magmas containing volatile substances can only be made in special apparatus capable of withstanding very high pressures, it has been urged that provision should be made in Great Britain for research in this field, and the paper by Dr. J. W. Evans outlines a very extensive programme of work which should be undertaken if means permitted, including the effect of shearing forces as well as of hydrostatic pressure.

Bowen's reaction principle comes in for some discussion, and the question is raised whether the methods used in metallography require much modification when they are applied to the study of such viscous and highly associated liquids as rock magmas. Prof. J. W. Gregory's detailed survey of the subject of magmatic ores leads to the remarkable conclusion that ores of magmatic origin are probably quite unimportant, all the famous deposits to which such an origin has been assigned having been shown to have been formed in other ways. The little volume is most interesting and suggestive.

A German-English Dictionary for Chemists. By Dr. Austin M. Patterson. First edition, with Addenda. Pp. xvi + 343. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 12s. 6d. net.

To compile a small dictionary from data easily available in larger works, is a comparatively simple task. To compile a small dictionary of a special character, like that now under review, requires not only judgment, accuracy, and application, but also a good knowledge of the languages and the science concerned. These qualifications Dr. Patterson possesses to an eminent degree, and therefore it occasions no surprise to learn that his "German-English Dictionary for Chemists" has been reprinted no less than five times, and that 21,000

copies of it have been sold since the first impression was made in 1917.

The book is excellent so far as it goes. It is obviously not intended for the linguistic expert, the professional translator, or for other serious students of German, but for the ordinary run of chemists, who to-day know little French and less German, it is remarkably good, being exactly what they require. With the aid of this small dictionary, such a chemist will be able to "make out" the meaning of almost any passage in a German chemical work; he will not, however, always be able to render it into precise and good English, because he will not always find the exact English equivalents of the German compound words he encounters. As a rule, such words are easy to understand, but alas! they are also easy to mistranslate, and they occur frequently in such branches as metallurgy, spectroscopy, atomic structure, economic and engineering chemistry. We hope, therefore, that when the work is revised, it will be found possible to include exact renderings of many more German compound words, so that we may be spared from errors like that made by the Frenchman who, when endeavouring to translate "hemisphere," looked up "hem" and "sphere," and then, uniting the French equivalents in unholy wedlock, wrote down the word—*demi-monde*!

Electrical Circuits and Machinery. By Prof. John H. Morecroft and Prof. Frederick W. Hehre. Vol. 2: Alternating Currents. Pp. xi+444 (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924) 20s. net.

THIS is the second of three volumes intended for the use of students in engineering colleges. The first was on continuous currents (now generally called in Great Britain direct currents). The final volume will describe "experiments." We think the authors have discussed their subject in a way which will be appreciated by the average student, who has generally a very limited time at his disposal. Although it is not sufficiently thorough to satisfy the consulting engineer, yet wherever possible without dragging in advanced mathematics, proofs are given. The art of the electrical engineer is ever advancing. Both the mercury arc and the thermionic valve rectifiers are included. Sub-stations with all their apparatus in the open air (outdoor sub-stations) are described. We notice that in the United States every large electrical company has an oscillograph, generally mounted on a truck, so that it can easily be transported to any point of the supply network.

We are glad that the authors insist that students must know the theory of the instruments they use. In too many cases students consider an ammeter, for example, as a piece of apparatus having two terminals, a pointer and a scale, and know little or nothing of what is happening inside. In alternating current machinery armature reaction plays the leading part, and due stress is laid on this. Particular attention is very properly devoted to the current and voltage relations of polyphase networks. Too many students are content simply to memorise the necessary formulæ without taking the trouble to understand their proofs. This slackness on their part will probably give them much trouble in the future, and they will never gain that confidence which is requisite for success.

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The Fauna of British India, including Ceylon and Burma. Edited by Sir Arthur E. Shipley; assisted by Dr. Hugh Scott. Coleoptera. Clavicornia. Erotylidae, Languriidae and Endomychidae. By G. J. Arrow. Pp. xvi+416 (London: Taylor and Francis, 1925) 30s.

THIS volume, which is the third contributed by Mr. G. J. Arrow to the "Fauna of British India" series, deals with three very closely related families of clavicorn Coleoptera, namely, the Erotylidae, Languriidae, and Endomychidae. They are all tropical groups that are but poorly represented in temperate regions. The Erotylidae recorded from the Indian fauna number 129 species, and Mr. Arrow has established the new sub-family Euxestinae for four exceptional genera which possess a rounded, solid club to the antenna. The Languriidae, with 110 Indian species, are not usually regarded as a separate family and most authorities place them among the Erotylidae. Mr. Arrow, however, considers them sufficiently distinct to merit family rank, but their affinities are so intermingled with the Erotylidae, Endomychidae, and Cryptophagidae that their taxonomic status is largely a matter of individual opinion. Unlike the Erotylidae and Endomychidae, the Languriidae feed as larvae in stems and the imagines are very characteristically elongated. The third family—the Endomychidae—includes 120 recorded Indian species included in three subfamilies.

It may be mentioned that in two features the present volume differs from its predecessors. First, there is a folding map of India and Ceylon, and secondly, there is an index of plant names. Both innovations add to the convenience of the users of the book. The illustrations include a chromolithographic plate and 75 excellent text-figures.

The whole work is well up to the standard of the previous volumes on Coleoptera, and Mr. Arrow is fortunate in being able to examine the original type-specimens in a large proportion of the species, a feature which gives additional value to his identifications.

A. D. I.

Christian Missions and Oriental Civilizations: a Study in Culture Contact. The Reactions of Non-Christian Peoples to Protestant Missions from the Standpoint of Individual and Group Behaviour. Outline, Materials, Problems, and Tentative Interpretations. By Dr. Maurice T. Price. Pp. xxvi+578 (Shanghai: Edward Evans and Sons, Ltd; London: G. E. Stechert and Co, 1924) 16s.

THIS book makes a wide appeal. It is of interest to those who are actively concerned with the work of Christian missions, to anthropologists, to psychologists, and sociologists, and to those who have to deal with the practical problems of administration. It approaches the work of the missionary from a novel point of view. It does not deal with spiritual, theological, or metaphysical interpretations as such; but it examines the reactions of non-Christian peoples to the Christian Church's attempt to convert them—both the initial and temporary responses and those which are more permanent. Missionary effort during the last one hundred years is surveyed from this point of view.

For the first time missionary effort has been studied as a natural phenomenon and as a social psychological

process, without partisanship or bias. The reader must not seek here for any panacea for the many ills arising out of the clash of cultures and ideals from which we are at present suffering in many parts of the world. This study is purely analytical. As the author points out, it is incomplete in the sense that further research is needed and consideration of the data available must be carried further in later volumes. The method is capable of an application wider than the mission field, and therefore deserves the careful consideration of all who are interested in the urgent problem of the future of primitive peoples.

Mechanical Design of Overhead Electrical Transmission Lines. By Edgar T. Painton. Pp. viii+274+26 plates. (London: Chapman and Hall, Ltd., 1925.) 21s net.

THE successful transmission of thousands of electrical horse-power by overhead wires over hundreds of miles is not only feasible, but has also been proved in almost every country to be attractive from the commercial point of view. Satisfactory operation has been attained by the continual attention that electrical engineers have been paying to the technique of design, and to the improvement of the quality of the materials used in construction. Continuous laboratory research and long experience have enabled them to anticipate operating difficulties, and combat them by selecting suitable materials and altering the design so as to raise the factor of safety. Of recent years long reports, papers, and patent specifications have been issued almost daily, and there are few who have the ability and the time to separate the grain from the chaff. This volume describes the latest constructional details, and makes references to the latest specifications issued by the British Engineering Standards Association, the American National Electric Light Association, and the Verband Deutscher Elektrotechniker. References are also given to many important papers published in the transactions of scientific institutions both at home and abroad. Novel data in connexion with steel cored aluminium conductors are given. These conductors are being extensively used, and necessitate changes in the details of transmission line design. This book can be recommended to both the practical and the academic engineer. The latter will see how many theorems given in examination papers have been modified to make them useful in practice.

Round the World in Folk Tales: a Regional Treatment.

Sixteen Stories from Various Lands, with a Chapter on their Meaning. Compiled and edited by Rachel M. Fleming. (Folk Stories for the Geography, History, and Reading Lesson.) Pp. xi+49+8 plates. (London: B. T. Batsford, Ltd., 1924.) 2s. net.

THE value of folk tales as illustrative material in education is now generally recognised. Miss Fleming has added to the indebtedness of teachers to her by the publication of this third collection of stories. It comprises sixteen stories drawn from widely scattered areas—Australia, Melanesia, Japan, China, America, Africa, Russia, and Brittany, to name some of the sources only. The bearing of the stories upon points of geography is perhaps more apparent than it was in the earlier volumes, and is further emphasised in an

introductory note. For example, "The Legend of the Flowers" from Australia is made to illustrate the effect of climate on vegetation and animal life, and in the same way, one of the Russian stories, extremes in climatic variation. Again character and quantity of food supply is a not unimportant feature which receives frequent mention, while the stories from Ireland and Brittany show the effect of the introduction of Christianity. The Bushman boy's account of some of the things told him by his mother might very well be used as the basis of a contrast in educational methods among civilised and uncivilised peoples. The bibliographical references are a useful guide for further study and add to the value of a book which should be widely used. The illustrations are interesting and well chosen, but might with advantage have been reproduced on a larger scale.

The Principles of Thermodynamics. By George Birtwistle. Pp. ix+163. (Cambridge: At the University Press, 1925.) 7s. 6d. net.

THIS admirable little book, based on lectures given by the author in the University of Cambridge to students of varied scientific interests, contains an account of the fundamental principles of thermodynamics and their main applications to the various branches of science. It opens with a brief account of the historical preliminaries leading to the two fundamental laws and the idea of entropy. After an account of the chief characteristic equations for fluids, the usual mathematical relations involving the thermodynamic potentials are discussed and applied to the more elementary cases of simple and compound systems. The book closes with four chapters dealing respectively with osmotic and vapour pressure, thermoelectric phenomena, specific heats, and radiation.

The whole treatment of the subject is brief and almost sketchy; but it is up-to-date, well-balanced, and wholly adequate, as no essential step is missed either in the physical argument or its mathematical development. The author has had the courage to cut out ruthlessly all matter which is irrelevant to his main theme, and the result is a thorough but handy account of the subject, in which the component parts are presented in their true aspect. No attempt is made at a critical survey of the fundamental ideas or at a discussion of the extensive statistical side of the subject; but these would obviously have been out of place in a first book on the subject. We may, perhaps, hope that the author has intentions of writing a second volume.

G. H. L.

Drogen und Drogenhandel im Altertum. Von Dr. Alfred Schmidt. Pp. viii+136+8 Tafeln. (Leipzig: J. A. Barth, 1924.) n p.

IT has been well said that no branch of knowledge can be adequately understood without an acquaintance with its history, and this applies in full measure to a knowledge of drugs. The study of the history of drugs, cosmetics, balsams, unguents, spices, etc., from the earliest written records to the present time, is so intensely interesting as to make it appear strange that so few pharmacognosists have devoted themselves to it. True, Tschirch, Schelenz, and a few others have collected data, but they have, as a rule, failed to present them in an attractive form.

From isolated details scattered among the works of numerous authors, Dr. Schmidt has endeavoured to build up a picture of the trade that was done in these materials, the extent to which they were used, and the routes by which they reached the various markets. He makes one realise that it was so considerable, and the traders so numerous, that thousands of years ago there were streets mainly occupied by their shops, and one can imagine one sees the buyers congregating there and comparing the wares offered.

To accomplish this has been a task of no inconsiderable magnitude, as any teacher can testify who has attempted to compile for his students a concise but intelligible history of drugs. To any one fairly conversant with German, the work is so fascinating that it can be read again and again. It contains a bibliography, and in addition there are numerous references in the text; it is full of most interesting details and is a valuable addition to the literature of pharmacognosy.

Qualitative Analyse und ihre wissenschaftliche Begründung. Von Prof. Dr. Wilhelm Böttger. Vierte bis siebente umgearbeitete und erweiterte Auflage. Pp. xvi + 644. (Leipzig: Wilhelm Engelmann, 1925.) 19 gold marks.

On reading this valuable work one is impressed by the fact that although the experimental data underlying qualitative analysis have changed but little, their interpretation has in many respects been revolutionised: the applications of the law of mass action and of the ionic theory of solution have brought order into the chaos and transformed what was once little more than a handicraft into a consistent and coherent science. Nearly twelve years have passed since the third edition of Böttger's work was noticed in these columns (December 18, 1913); the new edition is a very worthy successor to the old and gives a good idea of the advances that have been made in the interval. The first and more difficult part, dealing with the theoretical foundations, is particularly well done; the language is clear and simple, and the experimental illustrations are well chosen. Modern views on valency and molecular structure are treated at length, and there is an interesting section on electrolytes and Werner's theory.

In the experimental part are to be found many reactions of recent discovery, some of which are sufficiently specific to be used as tests without recourse to separation. The treatment generally is very full, and microchemical reactions have not been neglected. Books of this type are very few in these days of costly printing, and the appearance of the new and enlarged "Böttger" will be welcomed by all who are interested in this very old but still very fundamental branch of chemistry.

British Birds. Written and illustrated by Archibald Thorburn. In 4 vols. Vol. 1. New edition. Pp. xii + 176 + 48 plates. (London: Longmans, Green and Co., 1925.) 16s. net.

WE have received the first of the projected four volumes of a smaller and less costly edition of Mr. Thorburn's "British Birds," a book first issued on a sumptuous scale in 1915 and now out of print in its original form. The coloured plates, a new series, are again the principal feature, for Mr. Thorburn has a well-earned reputation

as an ornithological artist. They are usually clear and accurate, often beautiful, and on the whole well reproduced; a few, however, are noticeably less successful than the others. The text is undistinguished, consisting of very brief summaries of the usual text-book information plus a few comments, frequently in the form of quotations, upon habits or special points. This is unfortunate, for it is difficult to see what function a still rather expensive book giving so little information can fulfil.

One feels that the book should either have been brought within smaller compass altogether or have been expanded considerably in dealing with the more important birds. Either of these courses could have been followed had Mr. Thorburn been less subject to the fetish of that arbitrary category known as "the British list." Thus, no less than seven kinds of wheat-ear are each given a page, and all but two of them a place in the plates, whereas only one species is anything more than a very rare accidental wanderer to Britain. In a popular work there would be every advantage in dismissing accidental rarities with a bare mention. The confusion that there has been in ornithological nomenclature is to be regretted, but it does not help matters, now that some uniformity is being reached by general agreement, to find an author harking back for his standard to a work which was published in the previous century.

A Monograph of the Mycetozoa: a Descriptive Catalogue of the Species in the Herbarium of the British Museum. By Arthur Lister. Third edition, revised by Gulielma Lister. Pp. xxxii + 296 + 223 plates. (London: British Museum (Natural History), 1925.) 31s. 6d.

A THIRD edition of the monograph of the Mycetozoa by Arthur Lister has been prepared by Miss G. Lister and issued by the Trustees of the British Museum. Few groups of organisms have been so well catered for in the way of an accurate and well-illustrated systematic monograph: and the appearance of a third edition tells at once of the attractiveness of the organisms themselves and of the interest stimulated in any group when a sound treatise is available.

Biologists may have imagined that the Mycetozoa were fairly thoroughly known when the second edition, published in 1911 (which also introduced a revised nomenclature in accordance with the International Rules), included all additions to date. It is surprising, therefore, to note that no less than three additional genera, 46 species, and some 50 additional varieties, are incorporated in the present volume. The results of recent biological research are also included.

The work of revision having been in the experienced and accomplished hands of Miss Lister gives assurance that the new edition is of the same standard of excellence as its predecessor.

Faune de France. 8: Diptères; Tipulidæ. Par C. Pierre. (Fédération Française des Sociétés de Sciences Naturelles: Office Central de Faunistique.) Pp. 159. (Paris: Paul Lechevalier, 1924.) 25 francs.

THE present instalment of this useful series deals with the crane flies. Since the work is primarily intended for the identification of the adult insects, there is only a short account of their biology and metamorphoses.

Osten-Sacken's division of the family into Longipalpi and Brevipalpi is followed and four subfamilies are recognised, namely, Tipulinae, Cylindrotominae, Lomnobiinae and Trichocerinae. For the venation Tillyard's modification of the Comstock-Needham system is adopted.

The method of treatment of the family is by means of keys, which take the reader step by step from the subfamilies to the tribes and thence to genera and species. In the case of the larger genera the species are sorted out into groups in order to facilitate identification. The specific characters are further enumerated in a little more detail in the lists which follow the keys, and notes are given as to distribution and so on. The numerous text-figures are almost entirely devoted to the genitalia and venation, excepting two pages of illustrations which depict the larval and pupal characters of the Lomnobiinae. The work will prove useful to English dipterists, as very little has been published on the British forms for nearly forty years, excepting Edward's revisional notes (1921). A. D. I.

The Botany of Crop Plants: a Text and Reference Book.

By Prof. Wilfred W. Robbins. Second edition. Pp. xxi+674. (Philadelphia: P. Blakiston's Son and Co., 1924.) 3.50 dollars.

THE usefulness of this volume is indicated by the fact that a second edition has been called for in the comparatively short period of seven years. Opening with an outline morphological sketch, the author proceeds to give an account of the various crops grown in the United States, gathering together information that is otherwise very scattered. The crops are dealt with under the headings of their respective natural orders, the more important, chiefly cereals, being described in some detail. Bibliographies are appended to each crop or group of crops, but do not pretend to be complete. The classification of the varieties or types of crop is simplified by the free use of keys, many of which are original. A feature of the book is the "direct" method of labelling the very clear illustrations, thus rendering them more easy of reference for the student. A glossary of botanical terms and a good index round off a book that should prove of considerable value to agriculturists as well as to botanists.

Pecan-Growing By H. P. Stuckey and Prof. Edwin Jackson Kyle. (The Rural Science Series.) Pp. xiii+233+12 plates. (New York: The Macmillan Co., 1925.) 12s. 6d. net.

THE growing importance of the pecan-nut in American commerce has justified the production of this book dealing with the crop in all its aspects. The pecan, *Hicoria pecan*, is closely allied to the walnut, and now ranks second to the latter in the nut production of the United States. Propagation is not easy, and special attention is devoted to descriptions of the various methods of budding or grafting that it is necessary to employ. An interesting feature is the account of the National Pecan Growers' Exchange, an organisation for marketing the nuts by means of a grower's co-operative non-profit association without capital stock. Such a body tends to raise the standard of the crop owing to its system of careful grading and differential prices. Lax supervision in the earlier years of cultiva-

tion favoured the introduction and spread of many insect and fungus pests, which now need to be combated to prevent serious reduction of the nut crops. The volume concludes with a discussion of the food values and descriptive accounts of the many varieties of the pecan.

Distillation Principles. By C. Elliott. (Chemical Engineering Library: Second Series.) Pp. 166. (London: Ernest Benn, Ltd., 1925.) 6s. net.

MR. ELLIOTT'S book contains, on the whole, a clear and readable account of a subject which most students find difficult. In a few places the text is not so perspicuous as it might have been, but the general treatment is sound. Particular stress is laid on the work of Rosanoff, which the author says he has found helpful, and the methods adopted certainly appear practical and useful. A fair amount of mathematics is essential, but the full discussion of numerical results gives the treatment a sense of reality which is most gratifying. It may be noted (p. 24) that the molecular weight of hydrogen is not 2, and that 2 grams of hydrogen do not occupy 22.412 litres. Biot's vapour pressure formula (p. 21) is the only one given, whilst Kirchhoff's is perhaps more useful; Avogadro's law does not state (p. 34) that "the volumes of gases are proportional to their molecular weights." Useful tables are given in an appendix. The book can be recommended as a concise and accurate account of a difficult subject.

An Introduction to the Literature of Chemistry: for Senior Students and Research Chemists. By Dr. F. A. Mason. Pp. 41. (Oxford: Clarendon Press; London: Oxford University Press, 1925.) 2s. net.

THE idea of assisting the research student by explaining how to make use of the literature is a good one, and a satisfactory book on these lines would be most useful. Unfortunately, Dr. Mason has not made the most of his opportunity. He has omitted to mention many of the best works of reference, and his critical remarks are not always such as would meet with general agreement. The section on physical chemistry is particularly unsatisfactory, and no guidance as to consulting the literature is given in this part. In future editions, the author would do well to seek advice from specialists, and to find out what books are, in fact, most consulted in the large libraries. His lists read as though based on a rather arbitrarily selected private library.

Acid-Resisting Metals. By Sydney J. Tungay. (Chemical Engineering Library: Second Series.) Pp. 136. (London: Ernest Benn, Ltd., 1925.) 6s. net.

MR. TUNGAY deals with various types of acid-resisting metals, such as silicon-irons, lead and regulus metal, aluminium, stainless steels, monel metal, cast iron and steels, nickel and chromium alloys, copper and copper alloys, in an interesting way, and has succeeded in giving a large amount of useful information in small compass. The use of acid-resisting metals has changed many aspects of chemical engineering practice and holds out prospects of further applications. The information in the book, when it is not directly based on the author's own experience, is carefully compiled from good authorities, and the result is that one can rely on the correctness of the statements. The book can be warmly recommended.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Future of the British Patent Office.

THE burden of Mr Wyndham Hulme's letter (NATURE of September 5) is that, as regards basic principles in the granting of patents for inventions, there should be a reversion to the principles which obtained during Elizabethan and early Jacobean times, and that in every particular Patent law should be made subservient to the successful establishment of industries in Great Britain. Thus although a "manufacture" might have already been known, yet if it had not been reduced to practice, a valid patent should be obtainable by anyone who was the first to put the "manufacture" into practice. Further, Mr. Hulme contends that, if novelty is to be the test for validity of a patent, it is practically impossible for a thorough search to be made by a body of officials, and that since an administrative search for novelty has long been an economic absurdity, the growth of British industry should be stimulated by a relief of the patentee from an unduly high legal standard of novelty.

There is of course always much which deserves close attention in any of Mr. Hulme's observations upon Patent law and its administration and I regret therefore that I am not altogether in agreement with the views he is now expressing.

Dealing with the topics touched upon by Mr. Hulme, I think the nature of the consideration for a patent is quite clear, namely, the publication through the Patent Office of an invention which was new when the application for the Patent was made. I agree that the meaning of the term "new invention" has changed considerably during the last three hundred years. There is not much doubt that during early Jacobean times the test for novelty lay in the direction of discovering whether or no the patented invention had been "manufactured" in England. This arose from the fact that knowledge of an invention was much more likely to have been secured through it having been manufactured than through its having been described orally or in writing. But I doubt not that, even in these early times, "novelty" would have been destroyed if on a test case having been brought before the Courts, it had been proved that the industry or invention had been known in some way or other. Unfortunately, so few cases have been reported where patents were fought in early times. The decisions of the Privy Council are all right so far as they go, but the Council often acted despotically and was not very anxious to abide by the letter of the law where the supposed interests of the nation or the interests of favoured individuals were primarily concerned. A discussion, however, of the relation of the Privy Council to the Courts of Law is one that cannot be entered upon here beyond saying that there is ground for supposing that the Privy Council often usurped jurisdiction where patents for invention were in question.

When writing became a general method of transmitting information, it was not surprising that, early in the eighteenth century, the means for imparting information concerning a new invention was concentrated upon the "Specification" and that, in consequence, the prior publication, among other things, of a

writing which described an invention, should be held to be destructive of validity of a patent granted for that invention.

I think that there is a good deal to be said for the view that the original object of granting patents was the establishment of industries in England, and that if a patent was found not to have resulted in the establishment in this country as opposed to establishment in other countries, the consideration for the patent had failed. It is clear that the Courts of Law receded further and further from this view of the early law and that statute law attempted and still attempts to reinstate the original condition for the granting of patents. Whether the statutes have been successful or no is a matter upon which much diversity of opinion is present, and together with the question whether such restriction is advisable are subjects too big to deal with here.

As regards Mr. Hulme's two basic principles (a) and (b), I do not think that they are necessarily antagonistic, for in numberless instances the institution of a new industry has followed upon the disclosure of an invention. Indeed, I think it would be so difficult as to be impossible to grant patents upon the strength of the setting up of a new industry as opposed to the disclosure of an invention in writing deposited in a public office.

With respect to the granting of patents with relatively narrow claims, that necessarily and rightly follows when a search has shown that wider claims would interfere materially with the existing rights of the public. It is only just that when an inventor has added but little to the stock of public information, his monopoly rights should be proportionately reduced, and that when by an official search an inventor has been shown to be worthy of little protection, his patent rights should be virtually negligible. There is no reason, however, that when an individual has truly discovered an invention of immense and wide importance his patent, as is the case at the present day, should not be proportionately broad and his security of the highest. This means that I do not agree that when security is at its highest, restraining power is necessarily at its lowest.

The anonymous letter which Mr. Hulme quotes scarcely seems relevant. The practice of the United States Patent Office as regards claims and the law of the United States in respect of the interpretation of specifications and claims differ so much from ours that, granting what is said to be correct, the letter is but a complaint about patents granted in the United States of America.

With respect to search for novelty to which Mr. Hulme also refers, the complaint really comes down to saying that since perfection cannot be obtained in practice, it were better to have no search at all. I cannot agree to this, and I should have thought that the more thorough the search the more secure is the patent.

As regards relief of the patentee from the unduly high legal standard of novelty as mentioned by Mr. Hulme, it must be remembered that members of the public have the right to employ any extant information which has not been the subject of a patent, the term "extant information" including the associated knowledge which is the property of the expert or operative. It can scarcely be right that a patent should be granted to one who for his own purposes selects extant information, and that the public should be restrained from utilising what, before the patent was granted, they had a right to employ.

Concerning overlapping claims, I understand that it is the practice of the Patent Office to prevent this so far as it is possible. All of us are desirous of simpli-

fying procedure, but in our zeal for simplification we must be careful not to admit abuses.

I agree entirely with Mr. Hulme's conclusion; it is only when we face at close quarters the means to be adopted that we may find ourselves at variance.

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The Theory of Hearing.

A SERIES of communications by Scripture, Wilkin-son, and Hartridge concerning the mechanism of hearing has recently appeared in NATURE. In Prof. Scripture's most recent letter (February 14, p. 228), the work of Fletcher (*Phys. Rev.*, March 1924) and that of Wegel and Lane (*Phys. Rev.*, February 1924) are stated to be irreconcilable with the so-called "resonance theory" of hearing and as being in accord with a "pattern" or "deformation" theory which he advocates.

The definition of resonance in the popular sense involves the psychological factor of perceptibility of continued free vibrations after the driving force has ceased to act. If "resonance" is understood in this popular sense, the "resonance theory" of the cochlea is improperly named. Helmholtz took great pains to show that in order to explain "shakes," the vibrating areas on the basilar membrane cannot be "resonant." The damping of these selective areas obtained from data given in the Wegel and Lane paper indicates for the mid range of audible frequencies that the amplitude of free vibrations of each area diminishes to a value $1/e$ (roughly $1/3$) of its initial value in from 1 to 10 vibrations or in from 0.01 to 0.001 seconds. The vibrations are apparently not aperiodic but are highly damped. We may, therefore, conclude that the theory in question amply accounts for the suppression of free vibrations, *per se*, beyond the point of perceptibility, and, consequently, does not lead to the prediction of what Prof. Scripture calls "jangle" or "noise and jumble of sounds."

A description of the pattern of vibration of the basilar membrane as predicted by the "resonance theory" will perhaps make the matter clear. Fig. 1

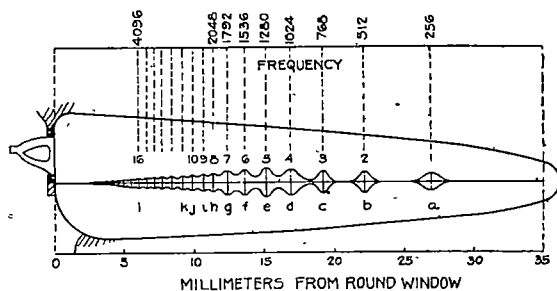


FIG. 1.

shows, in longitudinal section, the pattern of deformation of the basilar membrane in response to a sustained musical tone of pitch 256 (middle C). The amplitudes are, of course, enormously magnified when compared with the length of the membrane. This figure is made from quantitative data obtained from the paper (Wegel and Lane) referred to above. The pattern consists of a series of vibrating areas on the basilar membrane roughly elliptical in contour. These areas are larger and farther apart at the apical end of the membrane and closer together and tending to overlap near the basal end. The area, *a*, vibrates at 256 cycles or vibrations per second and corresponds to the fundamental or cord tone described in Prof.

Scripture's book "Elements of Experimental Phonetics." Area *b* vibrates at 512 cycles and corresponds to the second harmonic or first over-tone. Each harmonic is represented by a characteristic area. At points where two successive areas overlap, the membrane vibrates at the two frequencies simultaneously, causing a more or less irregular stimulation of the nerve terminals. If the relative amount of higher harmonics, which produces the overlapping areas, is so great that the resultant sensation is largely due to them, the sensation is that of poor musical quality.

If the pitch of the tone is changed, the pattern moves bodily along the membrane without great change in form. When, however, the pitch is exceedingly low, the areas, *a*, *b*, *c*, tend to be closer together and wider. When very high the maxima of the overlapping areas are crowded closer together. The loudness of the note depends on the absolute amplitudes of vibration of these areas and the quality depends chiefly on the ratios between the amplitudes. The sounds from a bell or cymbals, or from a vibrating plate or bar, produce patterns on the basilar membrane consisting of vibrating areas differently spaced from those shown in the figure. A noise disturbs the whole membrane instead of exciting separate areas in the simple manner indicated in the figure. Owing to the high damping, the vibrations of the membrane remain sensible only while the sound continues.

When a musical chord is sounded the pattern is more complex than in Fig. 1. The pattern for a tone of pitch 512 is like that in the figure for 256, except that it is displaced to the left a distance *a* *b*. If both tones are sounded together the resultant pattern consists of a superposition of the two patterns. The areas set in vibration by the higher tone coincide exactly with the even numbered areas excited by the lower one. The resulting amplitude at any one of the even numbered areas may be either smaller or greater than the amplitude there produced by either tone alone, depending on the phase differences of the tones. If the octave is not exact, beats result at the even numbered areas. If these beats are very rapid a discord results. A chord, consisting of several notes, results in a pattern on the basilar membrane consisting of the superposition of a number of patterns, properly spaced, each like that in the figure, one for each note in the chord.

The portamento or glissando, in order to be well executed, must take an appreciable time, say $\frac{1}{4}$ or $\frac{1}{2}$ second. A portamento through the octave 256 to 512 is represented by a shift of the pattern in the figure through a distance equal to *a* *b*, the pattern at any time being identical in position and form, so far as it would be possible to distinguish, with a pattern produced by a sustained tone of the identical pitch falling on the ear at that instant. The pattern resulting from the sound of Prof. Scripture's accelerated toothed wheel behaves similarly. A voiced sound in speech is represented by an appearance of such a pattern on the basilar membrane, a movement to and fro to correspond to the variation in pitch of the chord tone, a correlated variation in actual and relative amplitudes of vibration of the areas to correspond to changes in loudness and quality respectively, and a disappearance, all in sensibly exact synchronism with the spoken sound.

The sense of pitch of a tone is determined from the position of the root area, *a* (Fig. 1), of the series of areas on the membrane. When, for some reason, the lower harmonics are very faint or absent from the tone, the root and first few areas are missing from the pattern, but the root position, and therefore the pitch of the tone, may be inferred by a psycho-

logical process of association. The habit of association of the root area with the pattern position, therefore, accounts for Fletcher's experiments independently of the existence of non-linearity in the ear. When more and more low harmonics are eliminated, e.g. with filters, as in Fletcher's experiments, the sense of a definite pitch fades and merges into a high pitched noise having poor musical value.

At the higher levels of loudness, however, non-linearity (presumably greatest at the malleo-incal joint) undoubtedly comes into play. This compensates to a certain extent for cutting out the missing lower frequencies by resupplying them in more or less reduced amounts as difference tones, to the complex vibrations entering the cochlea. The result of this process is to give a more definite sense of pitch than association alone could do. Just what relative parts are played in Fletcher's experiments by association and by non-linearity is not certain, but experience certainly indicates that for loud sounds the latter plays a considerable part.

It will now be seen that Prof. Scripture's remarks concerning his own hypothesis apply equally well to the "resonance theory." Quoting from his article above referred to: "According to this [Scripture's] theory, the basilar membrane alters the linear movement of the stapes into a change of form in three dimensions. Every external vibration produces a pattern deformation of the membrane. This pattern is communicated to the brain. A single vibration of a clarinet tone produces a definite pattern in three directions on the basilar membrane. The mental quality of the clarinet tone represents this pattern. When this vibration is repeated regularly, the clarinet quality appears to be based on a tone of definite pitch."

An extended Helmholtz or resonance theory is the only present dynamical theory which conforms to the well-known laws of vibrational mechanics. The cochlear model of Wilkinson (*Journal of Laryngology and Otology*, September 1922) has demonstrated concretely that this type of mechanism is selective after the manner supposed by the resonance theory.

Progress in this field of investigation would be more rapid if those who are at work in it made greater efforts to understand each other's methods and terminology.

R. L. WEGEL.

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The Distribution of the Two Electrical Zones in the Atmosphere.

I HAVE examined the fair weather potential gradient on several mountains in the Bernese Oberland, and find that the positive zone, in summer at midday, extends from sea-level to above the Jungfrau (13,671 ft.). When observations at greater heights are available it may be found that it reaches up to between that and 20,000 ft. above sea-level in Central Europe.

As the positive potential was lowest before sunrise, and reached a maximum in the afternoon which was maintained until near sunset, it is possible that the outer negative zone approaches near to the earth's surface during the night, and recedes during the hours of daylight.

That the properties of this zone on the mountains are due to positive gas ions, is proved by the study of mountain mists. In the simplest cases the formation of mountain mists can indeed be followed by the eye, but at times those drifting from and covering the Bernese Oberland extend for several miles, and their origin and nature are then uncertain.

In most cases I find, on electrical examination, that the "clouds" surrounding the mountain tops in summer are in reality ground mists. They proved

to be positively charged on the Eiger, Jungfrau, Fischerhorn, Wetterhorn, and Faulhorn, and in each case they possessed the property of increasing the fine weather positive potential at the position temporarily, due to causes I have already described (*NATURE*, May 30, 1925, p. 836).

Electrical examination seems to be the only certain method of distinguishing between mountain mists and clouds, for on one occasion during broken weather a true upper cloud, negatively charged and optically indistinguishable from mist, descended for a time and surrounded the summit of the Faulhorn. Significantly, the temperature, which had stood at 10° C. for some hours, fell to 4° C. very rapidly. Hail, rain, and snow on the Faulhorn (8800 ft.) were always negative after the passage of the positive sheath.

When the magnificent panorama, seen in cloudless conditions from the summit of the Faulhorn, was examined about sunset I noted that there are two optical zones in the atmosphere, which are not noticeable at lower altitudes or when the sun is higher in the sky. The upper was clear and brilliant, and there was a lower, grey, hazy zone which rose from the ground-level to several thousand feet above Pilatus (7000 ft.) and Nollen (8800 ft.). The zones were most easily traced against the darker northern background, being lost among the dazzling snow-capped peaks of the Oberland.

During a cloudless sunrise the same zones were apparent, but the junction was considerably nearer to the summit of Pilatus than at sunset. It was when the lower edge of the sun's disc entered the lower zone that its red coloration became visible, and the Alpine glow commenced. As the lower zone extended higher above the horizon in the evening than at sunrise, this seems to account for the superiority of the sunset coloration, for at sunrise the solar disc quickly emerges above the lower zone.

It seems to me probable that the two optical and electrical zones are identical, and that the red colorations of sunset and sunrise are therefore largely due to absorption of solar radiation by positive gas ions (together with associated water molecules?). If further investigation confirms this view, an optical method of determining the height of the positive layer above the ground is provided, for the time of entry of the sun's disc into the lower zone can be fairly sharply determined on still cloudless evenings. The height of the lower layer is variable in strong winds and unsettled weather. Strong ionisation and absorption of solar radiation may occur in the outer layer of the positive zone.

In the light of a two-layer atmosphere the accepted explanation of the mirage may require revision.

As the height of the positive zone appears to be mainly a function of local absorption of solar radiation, recombination during darkness, resulting in shrinkage, we may expect the outer negative zone to approach much closer to the earth's surface in the Arctic and Antarctic circles during polar winters, and such thinning out of the positive zone may be a factor in the phenomena of the Aurora. A significant fact in this connexion is the absence of thunder and lightning near the Poles, to which Dr. Simpson has directed attention (*NATURE*, April 14, 1923, Supplement, p. x). I recently explained (*ibid.*) that disruptive discharge is due to the intense electrification resulting from the formation of the positive sheath about the negative clouds when the latter descend quickly into the lower positive zone, especially about the vanguard. Where the clouds do not descend into the positive layer there would be no sheath and no lightning.

Observations of the height of the positive zone during daylight and darkness are urgently wanted.

Ticlio (15,885 ft.), at the head of the Peruvian Central Railway, should provide an accessible site for the tropics. Alpine meteorologists have their choice of several positions. The mountains of northern Scandinavia, and Spitsbergen, would provide valuable data nearer the Pole. Once charted, mathematicians can calculate from the relative motion of the upper air and the earth how much of the earth's magnetism is explicable, and wireless experts can appraise the influence of the zones in long-range transmission.

In conclusion—a word of warning. I have previously shown that the enormous quantities of positive gas ions poured out from steam locomotives makes observation in England uncertain, and near towns entirely misleading. In Swiss valleys this factor is now negligible; but another disturbance exists there. At Grindelwald the spray from the turbulent Lutschine, and numerous waterfalls and cascades, carries its negative charge to considerable distances—200 yards on either side of the stream near the gorge. Water (like all conductors) in the open air has an induced negative charge on it in fair weather, and on severance the spray carries the negative charge with it.

WILLIAM C. REYNOLDS.

"Wharfedale," Upminster,
Essex, August 20.

The Motion of Eruptive Solar Prominences.

IN the issue of NATURE for July 4, p. 30, Mr. Evershed has reviewed a paper by Edison Pettit on the "Forms and Motions of the Solar Prominences." Dealing with the motion of eruptive prominences, Evershed thus summarises the opinion of Pettit: "The memoir concludes with a theoretical discussion of the nature of the repulsive force acting on prominences. Radiation pressure is rejected as inadequate, and the periodic ejection of showers of electrons from a disturbed area in the photosphere is suggested tentatively."

I have recently contributed a paper to the *Astro-physical Journal* in which the motion of eruptive prominences is discussed at some length. Working on the lines initiated by Saha and Milne, I have shown that selective radiation pressure provides the motive force for the motion of prominences. The selective radiation pressure is due to the bright patches or filaments which develop on the solar photosphere and are always found associated with eruptive prominences. St. John has recently shown that the spectra of the faculae and filaments show the lines of Ti⁺ much enhanced over those obtained from the undisturbed photosphere, and hence the conclusion is that they are regions of higher temperature.

Milne has shown that the high level Ca⁺ atoms emitting H and K lines are supported against gravity by the pressure of the photospheric radiation. When regions of the photosphere get locally heated the equilibrium in the region above is disturbed, and Ca⁺ emitting H and K and hydrogen atoms emitting the Balmer lines acquire an accelerated velocity. The motive power is thus obtained from the excess of radiation pressure due to the development of filaments at the base over the solar gravity.

Pettit, however, has shown that the motion is not accelerated but uniform for some time and then actuated by impulses. A steady velocity can only be reached if the particles move in a resisting medium. Probably the frictional force is supplied by the Einstein coefficient of resistance

$$R = \frac{8\pi h^2 \nu^4}{3c^5} \cdot \frac{e h \nu / kT}{e h \nu / kT - 1} \cdot \frac{B_{1 \rightarrow 2}}{1 + e^{-h \nu / kT}}$$

where $B_{1 \rightarrow 2}$ is Einstein's probability factor of

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absorption. Thus Pettit's results are not inconsistent with the theory. But in some cases, as Evershed has remarked, the motions of the eruptive prominences decidedly show continuous acceleration. These cases may be explained thus: The Einstein coefficient of resistance R works out to be a small number. The radiation pressure, on the other hand, may increase to a sufficiently high value, if the fluctuation of temperature or the size of the bright patch at the base is large enough. In this case the prominence will reach a great height before anything of the nature of a constant terminal velocity is acquired. In the meantime the velocity will continually increase, but the absolute magnitude of the acceleration will continually decrease. The impulsive increments in velocities are due to the sudden changes of temperature at the base.

All electrical theories must be discarded, for large motions are observed in the case of lines of hydrogen which are due to neutral atoms. Electrical forces cannot act on neutral atoms.

For detailed argument reference is to be made to the original paper.

RAMANI KANTO SUR.

Physics Department,
Allahabad University,
July 29.

I AGREE in a general way with the view that the motion of the eruptive prominences, and of the absorbing gases in novae, may be best explained by selective radiation pressure.

The structure of the chromosphere itself suggests an outward movement along innumerable streams or jets, which are perhaps based on the brighter spots in the rice-grain structure of the photosphere.

There is a difficulty when we study the distribution of the larger eruptive prominences with respect to the faculae, or brighter regions of the sun's disc. While it may be difficult to locate precisely the origin of eruptions when observed at the limb, they often seem to occur in high latitudes outside the spot-zones, and they appear usually to be connected with the larger patches of absorbing gas which are photographed on the disc of the sun in the calcium lines or in H α . These patches tend to lie outside the faculous regions, either in high latitudes or in longitudes intermediate between the great regions of sunspot disturbance. There is thus no evidence that the photosphere underlying these prominences is brighter than normal.

On the other hand, eruptions of a somewhat different character are observed in the immediate neighbourhood of sunspots, and these may be connected with the faculae. In rare instances they are accompanied by a phenomenon suggestive of the outburst of a nova, namely, a great but temporary increase of brilliancy in the photosphere, such as was observed by Carrington and Hodgson in 1859. Such disturbances are usually associated with line-shifts indicating motions of the order of hundreds of kilometres per second.

J. EVERSHERD.

Spermatogenesis of Spiders and the Chromosome Hypothesis of Heredity.

FROM certain observations which I have recently made, it would appear that the spermatogenesis of some spiders exhibits interesting peculiarities which do not readily accord with the rigid scheme required by the chromosome hypothesis of heredity.

I have more especially studied the spider *Palystes natalius* Karsch; but certain other spiders have

similar peculiarities in their spermatogenesis. The spermatogonial nuclei divide by amitosis only, and no trace of mitosis was seen in the numerous sections examined (Fig. 1). The spermatocyte nuclei form a more or less typical spireme in which many "chromomeres" develop (Fig. 2). The spireme breaks down and the "chromomeres" are left free; they grow into rounded chromatin granules of considerable size (Fig. 3). From these spermatocytes, spermatozoa arise in two ways, as follows:

(1) The spermatocyte nucleus buds or fragments in a somewhat irregular manner and gives rise to a small cluster of nuclei, each of which becomes surrounded by differentiated cytoplasm (Figs. 4-7). These small cells are the spermatids, and with the most careful observation it is not possible to affirm that only four spermatids are formed from one spermatocyte; in fact the number seems to be irregular and usually more than four. The nucleus of the spermatid becomes hollow and the chromatin concentrates at one pole and gives rise to the spermatozoon, which afterwards becomes spread over the swollen cytoplasmic vesicle like a fish-embryo stretched over its yolk-sac.

(2) The numerous chromatin granules of the spermatocyte condense and form a considerable

very considerable amount of amitosis normally occurs, and with the present evidence it seems totally impossible to assume that the offspring of cells which have divided by amitosis are incapable of dividing by typical karyokinesis.

It would be obviously absurd to suppose that the mechanism of heredity differs fundamentally in certain spiders from that in other organisms, and if these observations are duly confirmed, and I can see no escape from them, the upholders of the chromosome hypothesis, which naturally hangs on its weakest link, will have to be content with a much less rigid chromosome behaviour than is usually assumed.

A detailed account of the observations is being prepared for publication. ERNEST WARREN.

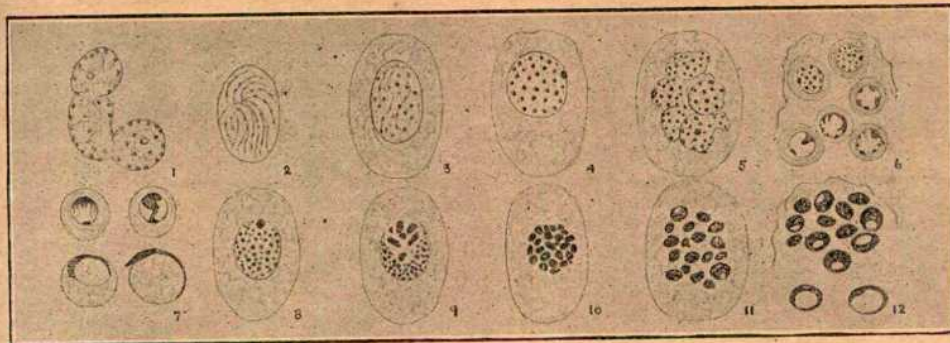
Natal Museum.

The Transmutation of Uranium into Uranium X.

As described in the *Journal for Applied Chemistry* (Berlin, Leipzig, No. 32, 1924), the present writer succeeded in 1922 in observing the transmutation of mercury into other elements, when submitted to the effect of a strong electric discharge. This discovery

was described in a manuscript deposited under G 56485 IV/12h on May 3, 1922, in the German Government Patent Office, where it may be seen by anybody. It is therefore incorrect to state that Miethe first observed the transmutation of mercury.

This must be expressly stated here in order to assert the priority of the



number of large masses resembling definitive chromosomes, but when first formed there seems to be no constancy in size, and also there is no definitely fixed number. Afterwards these chromatin masses become more or less rounded and uniform in size and the cytoplasm of the spermatocyte disappears almost entirely (Figs. 8-12). There is thus formed a compact cluster of oval, or rounded, free chromatin-bodies. Each of these bodies becomes hollow and produces one spermatozoon which is differentiated peripherally.

When mature the spermatozoa originating in this way are somewhat smaller than those formed according to the first method described above. These uncoiled or unexpanded spermatozoa may occur in abundance, mixed with expanded forms, in the semen contained in the spermathecae of the female spider. From this account it is clear that the "spermatocyte" produces far more than four spermatozoa.

It is of special interest to note that in the second method of spermatogenesis, traces of achromatic spindles may occur sporadically in association with the clusters of chromosome-like bodies, and these bodies may even become temporarily arranged in an erratic manner in the equatorial plane. It is as though the ancestral condition is not completely forgotten.

These peculiarities in the spermatogenesis of Palystes are doubtless associated with the fact that in the development of the tissues of the embryo a

present writer and to justify the further experiments carried out during the period 1922-1925 in a domain which was offering no promise at all at that time. After the discovery of the transmutation of mercury, it was natural that other elements, especially uranium and thorium, which are subject to spontaneous disintegration, should likewise be examined for the possibility of artificial transmutation.

For this purpose the behaviour of uranium and thorium and their salts in the electric arc and in the glow discharge in evacuated tubes has been examined. In no case could there be observed an alteration in the radioactivity or in the chemical activity. A perceptible transmutation effect was, however, unexpectedly found when strong rushes of momentary high-tension currents were sent through a narrow fused quartz tube provided with tungsten electrodes and containing mercury and uranium oxide. The tube was fixed vertically in a stand, so that the mercury filled the lower part of the tube and one tungsten electrode was completely covered by it. On the surface of the mercury was a relatively thin coating of uranium oxide which had been carefully freed from radioactive by-products, especially from uranium X, before it was introduced into the quartz tube. The sparking distance between the tungsten electrode and the mercury-uranium oxide electrode was about 15 cm. The intensity of the electric discharge varied between 0.3 and 0.4 amp.

Under the influence of repeated electric discharges during about thirty hours, relatively strong and

increasing radioactivity, measured according to the β - and γ -rays method, showed itself. The tube, hermetically sealed, was also laid on a photographic plate enclosed in an aluminium box. After six hours a very perceptible blackening appeared on the part of the photographic plate corresponding to the quartz tube. The contents of the tube were dissolved in nitric acid. From the solution the artificially produced radioactive material was separated by all the known methods by which uranium X can be separated from uranium. Observation of the decrease of the radioactivity showed the half-period time to be that of uranium X. The identity of the radioactive material generated with uranium X was thereby proved. The β and γ ray activity of the uranium oxide freed from the mercury varied between 1.4 and 20 times the radioactivity of an equally large amount of uranium oxide in equilibrium with its decay products, and increased proportionally to the energy applied and to the time.

One obtains even a greater production of uranium X if one makes, in analogy to the experiments of Nagaoka, as described in NATURE of July 18, the electric discharges pass within a thick-sided quartz or porcelain vessel between a tungsten point and mercury covered with a thin coating of vaseline and uranium oxide. This coating possesses such a high electric resistance that, even when applying the highest tensions which can be obtained, one is obliged to diminish greatly the sparking distance in order to obtain a discharge. This proceeding offers the advantage that the energy is concentrated into a very small space. Consequently one can show, after half an hour's work, the production of relatively large quantities of uranium X. It should be stated, of course, that before the tests all parts of the apparatus were examined as to radioactivity and found not to be radioactive.

The production of uranium X considerably in excess of that produced by spontaneous decay is to be explained only by the fact that, under the influence of the electric force, an acceleration of the radioactive transmutation of uranium takes place.

A. GASCHLER.

Motzstrasse, 72,
Berlin, W.30.

Some Simple Characteristic Relationships among the Ferromagnetics.

THERE are some simple relations existing among the ferromagnetic bodies which no doubt have a fundamental significance. If we calculate the ratio of the critical temperature on the absolute scale (θ) to the maximum intensity of magnetisation (I_0) for each of the ferromagnetics, we obtain the following values for θ/I_0 .

Iron	$1058/1817 = 0.58 = 2 \times \frac{2}{7}$
Cobalt	$1348/1422 = 0.95 = 3 \times \frac{2}{7}$
Nickel	$661/552 = 1.19 = 4 \times \frac{2}{7}$
Magnetite	$808/431 = 1.83 = 6 \times \frac{2}{7}$

Thus θ/I_0 is proportional to the simple numbers 2, 3, 4, and 6. The fraction $\frac{2}{7}$ is the numerical constant in the equation to the critical temperature, namely,

$$\frac{\theta}{I_0} = \frac{8a'}{27R},$$

where a' is the constant of the intrinsic field and R' is the reciprocal of Curie's constant.

We may ask if a new ferromagnetic material were to be discovered would it fit into this scheme; in

short, are these simple whole numbers necessary to ferromagnetism?

In Heusler's alloy we have such a new ferromagnetic material, and an examination of its properties provides one answer to this question. Recently Prof. Thompson kindly supplied me with a sample of this alloy, prepared in the metallurgical laboratory of the University of Manchester, and experiments with it show that its critical temperature is 355°C . or 628° on the absolute scale, and the maximum intensity of magnetisation is approximately 420. Hence the ratio of θ/I_0 is $628/420 = 1.50$, and this is very nearly $5 \times 8/27$. Thus Heusler's alloy conforms to the whole number rule, and, moreover, it fills the vacant space between nickel and magnetite, so that the consecutive numbers from 2 to 6 are now complete. These numbers are exactly whole numbers within the accuracy with which θ and I_0 are known.

When it is remembered that three of these ferromagnetics are metallic elements, one is a definite chemical compound and another is an alloy of three non-magnetic metals, these results are all the more remarkable.

There are one or two other simple relations closely connected with the foregoing: for example, the ratio of the maximum intensity of iron to that of nickel is 3.3, and the ratio of the intensity of cobalt to that of magnetite is likewise 3.3. Similarly the ratio of the critical temperatures of iron and nickel is 1.60, and of cobalt and magnetite 1.67; so that these ferromagnetics fall into two closely related groups.

J. R. ASHWORTH.

55 King Street, South,
Rochdale, August 20.

Planetary Densities and Gravitational Pressure.

WITH reference to Mr. Mallock's letter in NATURE of July 4, I beg to point out that the gravitational forces in his supposed envelopes will increase their density to a value comparable with that of a solid unless the planets are very hot indeed. The stability of the belts and spots on Jupiter and Saturn is a serious objection to the existence of such thick envelopes.

As to the compressibility of solids, the electrostatic theory of molecular structure is inconsistent with great increases of solid density. Surely Mr. Mallock's chalk experiment indicates that in the lower chalk the conditions are nearly crystalline and not that simple compression can produce important changes in density.

HERBERT CHATLEY.

Whangpoo Conservancy Board,
Shanghai, August 4.

The Word "Australopithecus" and Others.

IN answer to Dr. Lucas's letter (NATURE, Aug. 29, p. 315) it may be said that although scientific names need not be literature, and therefore need not follow any philological rules, yet where they pretend to be derived from Greek, or Latin, or any other particular language, good taste demands that they should conform to the structural system of that language.

We "scientists" are contemptuous when the unscientific misuse our terms: if we wish to avoid the contempt of literary folk, we should be careful how we use theirs.

F. J. ALLEN.

8 Halifax Road,
Cambridge,
August 30.

Organic Evolution.¹

By C. TATE REGAN, F.R.S.

FOR any profitable discussion of the origin of species it is essential to know what we mean when we use the word "species." In Nature we find that a number of similar individuals, with similar habits, live in a certain area; such an aggregation of individuals may be termed a community. It is unfortunate that this word has sometimes been used for dissimilar and unrelated organisms that occur together—for example, the animals found on a muddy bottom in the North Sea, or the plants of a range of chalk hills—but I am satisfied that the word "association" is more appropriate to these, and that "community" is the right name for a number of similar individuals that live together and breed together. All this is preliminary to my definition of a species. A species is a community, or a number of related communities, the distinctive morphological characters of which are, in the opinion of a competent systematist, sufficiently definite to entitle it, or them, to a specific name. Groups of higher or lower rank than species can be defined in a similar way. Thus a sub-species is a community, or a number of related communities, the distinctive morphological characters of which are not, in the systematist's opinion, sufficiently definite to merit a specific name, but are sufficient to demand a sub-specific name. Similarly a genus is a species, or a number of related species, the distinctive morphological characters of which entitle it, or them, to generic rank.

There are, of course, many species so distinct from all others and so uniform throughout their range that every one is agreed about them; but frequently the limits and contents of a species, as of a genus, are a matter of opinion. No systematist has, or should have, any rule as to the amount of difference required for the recognition of a species or a sub-species; he is guided by convenience. In practice it often happens that geographical forms, representing each other in different areas, are given only sub-specific rank, even when they are well defined, and that closely related forms, not easily distinguished, are given specific rank when they inhabit the same area but keep apart.

I have seen a species defined as a stable complex of genes—or words to that effect—and Bateson, without exactly defining a species, has insisted that those systematists who distinguish between good and bad species are right, and that the distinction between the two is not simply a question of degree or a matter of opinion. There is some truth in this; in the absence of exact knowledge, seasonal or sexual differences have been regarded as specific, and hybrids, as well as varieties that differ from the normal in some well-marked character, have been given specific names: these are certainly bad species. There is truth also in Bateson's contention that species are qualitatively different from varieties, if we restrict this word to the kind of varieties he has specially studied and do not use it for communities that differ from each other in morphological characters.

According to Bateson the principal qualities of species are morphological discontinuity and interspecific

sterility; but to the implication that these have been suddenly acquired, I would reply that in Nature there is every gradation from communities that are morphologically indistinguishable to others that are so different that every one is agreed that they are well-marked species; and it is not surprising that when morphological differentiation has proceeded to this extent it should generally, but not always, be accompanied by mutual infertility. That morphological discontinuity in a continuous environment which appears to Bateson to support the theory of the discontinuous origin of specific characters is seen to be the final term of a habitudinal discontinuity that began with the formation of communities that were at first morphologically identical. Bateson's argument, that the Natural Selection theory, or any theory of gradual transformation, demands that the ancestral form from which two species have diverged should persist as an intermediate is seen to be quite fallacious if we get a firm grip of the idea of the division of a species into communities, followed by the evolution of each community as a separate entity.

A great deal of work has been done, especially on our more important food-fishes, in making biometrical analyses and investigating the life-histories of the different communities.

I have studied with particular attention the fishes known as char, or salmonoid fishes of the genus *Salvelinus*. Char are very like trout in appearance, but have orange or scarlet spots instead of black ones; they inhabit the Arctic Ocean and in the autumn run up the rivers to breed in fresh water, often forming permanent freshwater colonies in lakes. There are many such colonies in the lakes of Scandinavia, of Switzerland, and of Scotland, Ireland, and the Lake District of England; the formation of these colonies must date back to glacial times, when these Arctic fishes occurred on our coasts and entered our rivers to breed. These lacustrine communities show considerable diversity in habits and also in structure; for example, the char of Lough Melvin in Ireland are quite unlike those of Loch Killin in Inverness in form, in coloration, in the shape of the mouth, and in the size of the scales; these differences are sufficient to entitle them to be regarded as different species, and I have so regarded them; but now I doubt whether it is not better to look upon all these lacustrine char, however well characterised, as belonging to the same species as the migratory char of the Arctic Ocean, for once you begin giving specific names to lacustrine forms of char you never know where to stop. But if we were to exterminate the char in the British Isles and on the Continent, except in a dozen selected lakes, we should have left a dozen well-marked forms which it would be convenient to recognise as species. A somewhat similar problem arises in the classification of man; it is convenient to place all the living races in one species. But if there were only Englishmen and Hottentots we should probably regard them as specifically distinct.

In our British char, habitudinal segregation—the formation of communities in lakes—has been followed by a geographical isolation which commenced at the

¹ From the presidential address delivered at Southampton on August 28 before Section D (Zoology) of the British Association.

end of the glacial period, when the migratory char retreated northwards. The char of each lake have evolved separately, and one can see clearly how many of the differences between them are related to the conditions of life; for example, the large eyes of the Loch Rannoch char, which lives in a very deep lake, and the blunt snout and rounded subterminal mouth of several kinds which always feed at the bottom. I confess that I do not understand why the scales are much smaller and more numerous in the char of some lakes than in those of others, but I suspect that these differences in scaling are the expression of physiological differences, and are the result of differences in the environment or in the activities of the fish.

The genus *Salmo* comprises about ten species from the North Atlantic and the North Pacific, and I have shown that the salmon and trout of the Atlantic form one natural group and those of the Pacific another. Our own salmon and trout are two closely related species; both of them range in the sea from Iceland and northern Norway to the Bay of Biscay, both enter rivers to breed, and in both the young fish, known as parr, remain in fresh water until they are about two years old and six inches long, and then go to the sea. From Mr. F. G. Richmond, a well-known pisciculturist, I have the information that although at certain seasons the parr of both salmon and trout may eat the same kind of food—for example, both take flies at the surface—yet on the whole their food and feeding habits appear to be different. Salmon parr seek their food, such as insect larvæ, small molluscs and crustaceans, on the bottom, whereas young trout tend to keep in mid-water and to subsist more on water-borne food; thus the salmon parr may be hunting for food in a stretch of shallow rapid water, while the young trout wait for it in the quieter water just below. When they are about six inches long the parr of both species become silvery and are termed smolts; the trout smolts go to the sea in a leisurely manner, hanging about the estuaries, and the older fish frequent the coastal waters; but the salmon smolts make straight for the open sea and there grow much faster than the trout, attaining a weight of several pounds in a year.

I have gone into these details because I think it is important to establish that two closely related species in the same area have different habits, and to a large extent avoid competing with each other.

The morphological differences between salmon and trout are slight. The salmon, more active and a stronger swimmer, is more regularly fusiform in shape and has a more slender tail and a more spreading and more deeply emarginate caudal fin, differences of the same kind but not of the same extent as between a perch and a mackerel. The rows of scales between the adipose fin and the lateral line are usually fewer (10 to 13) in the salmon than in the trout (12 to 16); but this may be directly related to the fact that the tail is more slender. On an average the salmon has one ray more in the dorsal fin than the trout, and I am tempted to regard this as a step towards that increased number and concentration of the dorsal rays which is so characteristic of swift-swimming pelagic fishes. The last difference between the two species—the smaller mouth of the salmon—may be related to the food and feeding habits of the parr. In structure as in habits the salmon

is more specialised than the trout, and may have evolved from it. The salmon is found on the Atlantic coast of North America, where there are no trout; but I think this is because its habit of going farther out to sea has given it a greater opportunity of extending its range. There can be little doubt that the differentiation of these species has been not geographical but habitual, comparable to the differentiation of the coastal and open-sea herrings.

In every river and lake that it enters, the trout forms freshwater colonies, and on the other side of the Atlantic the salmon does so fairly readily, although not nearly so generally as the trout does on this side. In Europe, trout being present, the salmon forms freshwater colonies only in exceptional circumstances. Thus Lake Wenern in Sweden, now cut off from the sea by inaccessible falls, has a stock of salmon; there can be no doubt that in former times salmon entered the lake and bred in its tributaries, and that some of the smolts, when they reached the lake on their seaward migration, considered this very large lake a sufficiently good substitute for the sea to stay there, and so founded a lacustrine race.

Freshwater colonies of trout are found in the Atlas Mountains and in the countries north of the Mediterranean eastwards to the Adriatic, proving that in glacial times the range of sea-trout extended southward to the Mediterranean. The rivers of Dalmatia and Albania are inhabited not only by trout but also by fish of another species, known as *Salmo obtusirostris*. This little fish, which never grows larger than fifteen inches long, has all the structural characters that distinguish salmon from trout, and, indeed, looks very like an overgrown salmon parr; but when compared with salmon of the same size it is seen to differ in having a considerably smaller mouth, weaker teeth, and more numerous gill-rakers (15 to 18 instead of 11 to 14 on the lower part of the first arch). In fishes generally the number and length of the gill-rakers—projections from the gill-arches that prevent food from entering the gill-chamber with the respiratory current—are related to the nature of the food; thus, in exclusively piscivorous fishes, such as the pike, they are represented by a few short knobs, and in feeders on minute plankton organisms they are very numerous, long, slender, and close-set. It has been recorded that *Salmo obtusirostris* subsists mainly on the larvæ of Ephemeridæ, which are very abundant in the rivers it inhabits, and there can be no doubt that the small size of the mouth, the feeble dentition, and the increased number of gill-rakers are related to this diet.

The presence of this fish in the rivers of the east side of the Adriatic seems to me to point to the probability that in glacial times salmon, as well as trout, occurred in the Mediterranean, and that in these rivers some of the salmon parr, tempted by the abundance of parr food, preferred to continue the parr life instead of going to the sea as smolts, thus forming a freshwater colony in quite a different way from the salmon of Lake Wenern. The question may be asked: If these fishes are derived from salmon and live in the same way as salmon parr, how can their differences from salmon be adaptive? The reply to this is that the size of the mouth in the salmon parr must have some relation to the fact that it is going to become a salmon, feeding on fishes in the sea,

and that, as *S. obtusirostris* grows to twice the length of a salmon parr, we should expect the number of gill-rakers to be increased, for it is not number but the size of the interspaces that is important in relation to food.

The work of Dr. Johannes Schmidt on the viviparous blenny (*Zoarces viviparus*) is of great interest. He found that samples of *Zoarces* from various parts of the Kattegat and Baltic differed slightly, but generally had an average of about 118 vertebræ, but that in the shallow Danish fiords the number was less, and decreased progressively the farther the distance from the sea. Conditions of temperature, salinity, etc., are very different in the different fiords, and I am inclined to think that the critical character common to all of them is that they give the *Zoarces* an opportunity of leading a quiet life amidst a plentiful supply of food; hence the fiord *Zoarces* can be distinguished at a glance from those outside by their shorter and deeper form. For example, in the Mariager Fiord, a narrow inlet about twenty miles long, the average number of vertebræ decreases from 115 at the mouth to 111 about seven miles inland and 110 about fifteen miles inland; two samples from the extreme end of the fiord and from a point four miles from the end both showed exactly the same average, 109.3.

There can be no doubt that the fiords were originally populated from the outside, and it seems likely that the decreased number of vertebræ in the fiords is related to the lesser activity of the fiord fish. Evolution has proceeded to such an extent that the *Zoarces* of the Roskilde Fiord differs from that of the Kattegat more than does the European eel from the American, and these are generally regarded as good species. But the repetition of the same phenomenon in different fiords, and the continuous gradation from one form to another, make it impossible to recognise species here. *Zoarces* are very stationary, but possibly the young are more migratory than the adults. If we suppose that these fishes move on an average a mile a year, or even less, and mate with the nearest fish of the opposite sex, we can understand how the tendency to form a pure fiord race is hampered by continuous interchange, and how the influence of the outside form gradually diminishes until in the innermost waters it is not felt at all and isolation is accomplished. In each fiord a series of intermediates, hybrids if we like so to term them, connect two well-differentiated communities, one in the sea, the other in the inner waters of the fiord.

These detailed examples are sufficient to illustrate my view that some form of isolation, either physical or produced by localisation or by habitudinal segregation, is a condition of the evolution of a new species. The effects of physical isolation, due to the formation of a barrier, are well seen in comparing the fishes of the Atlantic and Pacific coasts of Central America, most of which can be paired, one species being found on the Atlantic side and its nearest ally on the Pacific side. The effects of habitudinal segregation are, as it seems to me, seen in the cichlid fishes of Lake Tanganyika, where there are ninety species that appear to have evolved in the lake from two ancestral forms; the differences between these species in the form and size of the mouth, and in the dentition, are an indication that their diversity is related to specialisation for different kinds of food.

The whole of my work leads to the conclusion that the first step in the origin of a new species is not a change of structure, but the formation of a community either with new habits or in a new or a restricted environment. For some species we know fairly certainly what has happened, and where, when, and why: Shall we ever know how? Experimental attempts to repeat the operations of Nature might perhaps give us a clue, but I do not expect one from experiments of the kind that are so fashionable nowadays.

For example, if *Salmo salar* and *Salmo obtusirostris* could be bred together, it would not matter much whether the hybrids were sterile or fertile; and if they were fertile it would not interest me to know that the variation in their offspring could be squared with the factorial hypothesis by the ingenious assumption that there were several factors for both larger mouth and smaller mouth and for fewer gill-rakers and more gill-rakers. Even if the number of gill-rakers in either species could be increased or decreased by thyroid extract, I should still be unconvinced that we had got much nearer to the root of the matter. . . .

Throughout, the evolution of fishes illustrates the same principles. Changes of structure have been intimately related to, and may even be said to have been determined by, changes of habits, and especially changes of food and of feeding habits. Evolution has been adaptive, but modifications of structure that were originally adaptive persist when they are so no longer; they become historical and the basis for further adaptive modifications. I am satisfied that these principles, which I have illustrated by examples from the group I have specially studied, have a general application.

Darwin's theory of evolution was that it had been accomplished mainly by natural selection, aided by the inherited effects of use and disuse. Whether that theory be permanent or not, it was put forward by a man pre-eminent for his wide knowledge and his great reasoning powers, who knew the facts that had to be explained and gave us a theory that explained them. The "Origin of Species" still remains the one book essential for the student of evolution.

Darwin has been criticised because, we are told, he did not know that there were two sorts of variations—mutations, which are inherited, and fluctuations, which vary about a mean and are not inherited. But when you point out to a mutationist that the heredity of many fluctuating variations has been proved—parents above the mean, for example, giving offspring above the mean—he tells you that that shows that the variation is not really fluctuating, but only apparently so, and that a large number of "factors" must be involved. This is in effect a complete withdrawal, for it amounts to an admission that Darwin was right if he considered that these types of variation differed only in size and frequency.

There are other critics, however, who admit that at any rate some fluctuations are inherited but say that the effect produced on a population by selection is limited; elimination of certain types will change the average, but will produce nothing new. This criticism has also, as it seems to me, been disproved experimentally; for example, by De Vries, who from two plants of clover in which a few leaves were four-lobed produced by selection a variety in which the number of

lobes of the leaves varied from three to seven, fluctuating about a mean of five. Incidentally this experiment shows the relation between mutations and fluctuations.

The criticism that many specific characters are non-adaptive merely amounts to this, that we do not know the meaning of many specific characters. Moreover, we are not likely to for a long time, for a prolonged study would be necessary to understand fully the meaning of the differences between any two species, to determine which characters were adaptive, which historical, which due to the environment, and which the expression of metabolic differences.

If these criticisms of the natural selection theory can be met, it does not follow that it is a complete theory. It may be a sufficient explanation of certain types of evolution, and one cannot wonder that those who have studied mimicry in insects are firmly convinced of its truth; but the evolution of the dodo, and of the blind fishes of subterranean waters, put rather a strain on the theory and almost demand the recognition of the inheritance of the effects of use and disuse.

If this be admitted, if the adaptive responses of an organism to changed habits and changed conditions make it possible for subsequent generations to respond with greater effect, then the part played by natural selection in evolution of this kind would be subsidiary, the selection of those individuals who responded earlier or better than their fellows. How well this idea fits in with that fundamental generalisation, the law of recapitulation, which states that ontogeny tends to repeat phylogeny, and that the more remote the ancestor the earlier it will be represented in the developmental history! This generalisation, based on embryological data, has since received strong support from palaeontological evidence.

Most people are aware that a flat-fish when first hatched is symmetrical and swims vertically, but that at an early age one eye migrates round the top of the head to the other side, and the little fish sinks to the bottom and henceforth lives with the eyed side uppermost. But perhaps it is not so well known that it has been shown that almost as soon as the fish is hatched the cartilaginous supraorbital bar above the eye that is going to migrate begins to be absorbed, and is eventually represented only by short processes of the otic and ethmoid cartilages, with a wide gap between them. Through this gap the eye migrates, with the result that, when ossification begins, the main part of one frontal bone is on the wrong side of its eye. The flat-fishes are an offshoot of the perch group, and it is known that some of these have a habit of resting on one side. If such a fish found it profitable to lie in wait for its prey in this position, it would naturally try to make some use of the eye of the under side, pressing it upwards against the edge of the frontal bone. In the flat-fishes the migration of the eye into and across the territory of the frontal bone, prepared for by the absorption of the cartilaginous precursor of the frontal bone before the eye shows any sign of migration, may well be interpreted as the final stage of a process thus initiated.

You will have seen, then, that I am inclined to accept Darwin's theory as a whole, including both natural selection and the inherited effects of use and disuse, at any rate until some better explanation of the facts is forthcoming. But still there are difficulties,

and to illustrate them I must give one more example from the fishes.

The most primitive spiny-rayed fishes are the Berycoids, which flourished in Cretaceous times; in some of these the vertebræ number 24—10 præcaudal and 14 caudal. In many families of Percoids, not at all closely related to each other, we find this number of vertebræ is a constant family character; for example, all the genera and species of sea-breams (Sparidae), red mullets (Mullidae), chætodonts (Chætodontidae), grey mullets (Mugilidae), and barracudas (Sphyrænidæ) have 24 (10+14) vertebræ. The conclusion is inevitable that this is a primitive percoid character derived from a berycoid ancestor. Yet we have clear evidence that whenever the circumstances demanded it this number could be decreased or increased. There is no variation and therefore no material for selection; also the number of vertebræ is settled at a very early stage, and no fish can increase or diminish that number in its lifetime. Psettodes, the most primitive living flat-fish, has 24 (10+14) vertebræ; it is simply an asymmetrical perch. It has a large mouth and strong, sharp teeth, and its principal movements are probably short dashes after fishes that come near enough to be caught. But in other flat-fishes the number of vertebræ is greater: in the sole, which feeds on small invertebrates that it finds in the sands, and swims along with undulating movements of the whole body, the number is about fifty, and in the tongue-soles (Cynoglossus) there may be so many as seventy vertebræ.

We are almost compelled to believe that muscular movements, the efforts of a fish to swim in a certain way, may lead to an alteration in the number of muscle segments of its descendants; the number of vertebræ is, of course, determined by the number of muscle segments. This is an extension of the Lamarckian theory, and some may regard it as a teleological speculation unworthy of serious consideration; some may even think that, as my suggested explanation is incredible, we have here another example of the truth of the mutation theory, which in effect states that it is only by accident that a structure has a function.

Many biologists have adopted Weismann's germ-plasm hypothesis so whole-heartedly that they seem to regard it as a final disproof of Lamarck's theory. But when we consider that in progressive evolution, as in the development of the individual, increasing complexity of structure and localisation of functions is accompanied by co-ordination of the activities of all the parts, that differentiation and integration go together and the organism remains a unit, the so-called "inheritance of acquired characters" seems no more unlikely in the most advanced Metazoa than in the simplest unicellular organisms; and in some of these it has been proved.

When I read Huxley's essays as an undergraduate I was greatly impressed with his remark that "Suffer fools gladly" was very good advice. If a man does not agree with you, try to find out why he thinks as he does; you may discover the weakness of your own position. We should not adopt theories as creeds and denounce other theories as heresies. We are more likely to make progress towards the solution of the problem of evolution if we keep open minds and take broad views.

The British Association: Connexion with Oxford.

AT the close of the first meeting of the British Association, held at York in 1831, the assembly stood adjourned to Oxford, the Rev. Prof. William Buckland becoming president-elect. Before the meeting dissolved, a speaker declared that in his opinion the Association was destined "greatly to enlarge the boundaries of science, and in so doing advance the many interests of human nature which depend upon the improvement of knowledge." It was all very tentative then, a matter indeed of faith, and faith sustained hope.

The train was thus laid for the second meeting held at Oxford in 1832. Since that date three other gatherings have met in the city, namely, 1847 (Sir R. H. Inglis, Bart., F.R.S., president); 1860 (Lord Wrottesley, F.R.S., president); 1894 (the Marquis of Salisbury, K.G., F.R.S., president). Next year, as we know, H.R.H. the Prince of Wales will occupy the presidential chair at Oxford.

Buckland, at the time of his appointment as president, was an enormous asset to the well-being of the first-born of York—a child able to walk, scarcely to run. He was a fellow of the Royal Society, and a past-president of the Geological Society. Moreover, he possessed agreeable social qualities, not least of which was a keen sense of humour. He had a habit of carrying about with him a large blue bag, containing fossils. Once, he said, he paid a visit to Sir Humphry Davy. "Has Dr. Buckland not called to-day?" inquired Sir Humphry. "No, sir," said the servant, "there has been nobody here to-day, but a man with a bag, who has been here three or four times, and I always told him you were out."

Buckland's address upon taking up the duties of his office was brief, in no way comparable with present-day extended surveys. He, however, gave a lecture on the fossil remains of the Megatherium. Cuvier had died on May 13 in the same year, and Buckland took occasion to give eloquent expression to the loss sustained by the death of that illustrious naturalist and leader. In the mid-week, at a general meeting, the first award of the Wollaston gold medal was made by Roderick Murchison, the president of the Geological Society, to William Smith, the acknowledged "Father of English Geology."

A voluminous report was presented by J. F. W. Johnstone on the recent progress and present state of chemical science. At an evening meeting Dr. Ritchie delivered a lecture on "Magnetic Electricity," with reference especially to recent discoveries of Faraday. Brunel gave an account of the attempt to carry a tunnel under the Thames.

At a Convocation, honorary degrees were conferred on Sir David Brewster, Robert Brown, John Dalton, and Michael Faraday, a "hodge-podge of philosophers," commented Keble.

Fifteen years had elapsed before the Association met again at Oxford in 1847. By then the permanence and stability of the organisation was fully assured, the boundaries of scientific effort advanced in all directions. The chair was taken by Sir Robert H. Inglis, member of Parliament for the University. We may conclude that the latter qualification really led

to his selection. He was a politician, one who opposed the repeal of the Corn Laws; a country gentleman with a genial manner, and capable of making friends; one also who took great interest in learned and religious societies, but, as chronicled by his biographer, "with many prejudices and of no great ability." We get a glimpse of views entertained by the president of the wonder-working electric telegraph. Sir Robert Inglis expressed regret that so great a discovery had been inadequately welcomed in Great Britain. Yet in the discharge of public business was it not important? He had had an opportunity of examining the telegraph in the lobby of the House of Commons, by means of which communication passed to distant rooms. He gave specimens of information thus conveyed: "Committee has permission to sit until five o'clock"; and among questions sent down were the following: "What is before the House?" "Who is speaking?" "How long before the House divides?"

John Couch Adams, the discoverer of the planet Neptune, made personal acquaintance with Leverrier at this meeting, and both were Sir John Herschel's guests. Leverrier's indications had supplied the basis for the location of the planet in 1846, but months earlier Adams had set down the data.

Dr. Schunck discoursed on colouring matters. Edwin Lankester read a paper "On the Plant which yields Gutta Serena," and prophesied its application as probably "very extensive." Owen, too, was at the meeting, and Ruskin, as secretary of the Geological Section. The youthful Huxley sent from H.M. *Rattlesnake* a paper on the corpuscles of the blood of *Amphioxus lanceolatus*. Faraday exhibited three specimens of diamonds received from M. Dumas, which had been subjected to intense heat. Joule read a paper (the third) on the mechanical equivalent of heat, which was, remarks Mr. Howarth, heard by both Faraday and Thomson (afterwards Lord Kelvin), the second of whom perceived that "it contained a great truth and a great discovery."

The Association did not return to Oxford until 1860, Lord Wrottesley becoming president. For four years (1854-58) his lordship had occupied the presidential chair at the Royal Society, earlier (1841-43) that at the Royal Astronomical Society. Hence he brought distinction and experience to his new office. Lord Wrottesley's address dealt rather fully with astronomical subjects. The important event of the opening of the New Museum at Oxford was referred to as an omen of bright hope in the diffusion of science. It is well to go back upon the past and quote the president's remarks respecting practical applications of chemistry. "We may refer," he said, "to the beautiful dyes now extracted from aniline, an organic basis formerly obtained as a chemical curiosity from the product of the distillation of coal-tar, but now manufactured by the hundred-weight in consequence of the extensive demand for the beautiful colours known as mauve, magenta, and solferino." In physiology, note was made of great and steady advances in the chemical history of nutrition, and of the electricity of nerves and muscles. The recent return of McClintock from the search for Sir John Franklin

was alluded to. The "Voyage of the *Fox* in the Arctic Seas" had been published late in 1859.

Passing to sectional details, it is incumbent to recall two papers read at Oxford at this time, respectively by Dr. Daubeny and Prof. Draper, of New York. Darwin's "Origin of Species" had appeared in 1859, of which by 1860 no fewer than eleven editions had been issued. These communications offered but cautious approbation of Darwin's researches. In itself, Draper's paper embodied an attempt to show that the advance of man in civilisation does not occur accidentally or in a fortuitous manner, but is determined by immutable law. From his work on physiology, published in 1856, he gave his views in support of the doctrine of the transmutation of species, the transitional forms of the animal and also the human type, the production of new ethnical elements or nations, and the laws of their origin, duration, and death. We must go outside the official Report of the Association for the year to piece together the records of the controversy and storm of words which waxed and raged round these communications; in a sense they were but stalking-horses, in any event traps for the unwary. Yet, looking back upon this mixed chapter of scientific and clerical polemics, the happenings all seemed inevitable. The stage was set, the disputants in place. Prof. Buckman sent a further report, on experimental plots in the botanical garden of the Royal Agricultural College, Cirencester, while Lawes and Gilbert again entered the domain of classic inquiries with a paper on the "Composition of the Ash of Wheat grown under various circumstances." Capt. Maury, of the U.S. Navy, had written to the president urging attention to Antarctic exploration, concluding cheerily with the words, "So trusting and hoping that you will join with me in the cry 'Ho for the South Pole!'" William Fairbairn reported experiments to determine the effect of vibratory action and long-continued changes of load upon wrought-iron girders.

In 1894 the Association again chose Oxford, after what Lord Salisbury, the president, and Chancellor of the University, termed "a long and dreary interval of separation of thirty-four years." Consequently a new generation participated in the proceedings of the reunion. The gathering was a great success, 2321 persons taking up membership, while no fewer than 77 foreign members attended, including Prof. Mittag-Leffler, Prof. Ludwig Boltzmann, Dr. S. P. Langley, M. Cornu, Prof. E. Van Beneden and Prof. Strasburger. One is painfully conscious in looking over the roll that time has brought about the removal of many eminent personalities in science since Oxford last received the Association.

Certainly the most notable occurrence at the meeting was the announcement by Lord Rayleigh and Prof. William Ramsay of the discovery of a new gas in the

atmosphere—argon. It fell to Sir Henry Roscoe to propose a vote of congratulation.

The president's address was prefaced by the open confession that he was, after all, only a layman, and "all the skill of all the chemists the Association contains will not transmute a layman into any more precious kind of metal." Nevertheless, the discourse provided a distinctive summary of advances, and comments thereon. In Lord Kelvin's view there was throughout "the spirit of the student, the spirit of the man of science." Prof. Huxley seconded a vote of thanks. It was reserved for an eminent mathematician and publicist to write later: "We find nothing in it which shows either the student or man of science; it teems with fallacious conclusions; and whatever may have been intended by the author, it can only serve as an appeal to the gallery, which is occupied by the reconstructed theological party."

In one of the sections Hiram Maxim gave a description of his experiments on flying by means of aeroplanes. Mr. Henry Balfour, in a paper on the evolution of the bow as a musical instrument, gave the aboriginal races of Africa and India the credit of providing the prototype of many of our best stringed instruments. Mr. Preece discoursed on signalling through space. Sir Andrew Noble told of his methods for measuring pressures in the bores of guns; that the earliest attempt, by direct experiment, to ascertain pressures developed by fired gunpowder, was that made by Count Rumford; but Sir Andrew pointed out assumptions and erroneous determinations. Lord Salisbury attended Prof. Rücker's address in the mathematical section; afterwards an adjournment was made to the Clarendon Laboratory to hear Lord Kelvin describe experiments on the electrification of the air. Prof. H. B. Dixon, president of the section of chemical science, took as his subject "An Oxford School of Chemistry." "If it be a true saying," he remarked, "that men here imbibe a liberal education from the very air breathed by Locke and Berkeley, surely we also may draw scientific inspiration from this air, not only breathed, but first explained, by Boyle, and Hooke, and Mayow."

Two evening lectures were delivered (1) by Dr. J. W. Gregory, on "Experiences and Prospects of African Exploration"; (2) by Prof. J.-S. Nicholson, on "Historical Progress and Ideal Socialism"; the lecture to the operative classes was by Prof. Sollas, on "Geologies and Deluges."

There was an overflowing attendance at the Sheldonian Theatre to hear Lord Salisbury's presidential address. It seems that numbers of volunteer helpers were swept aside, through the determined inrush of visitors, and thus were unable to perform their functions. An experience such as this will doubtless be borne in mind on the occasion of the meeting to be held next year.

T. E. JAMES.

Recent Developments in the Theory of Magnetism.¹

By Prof. C. G. DARWIN, F.R.S.

THERE have been several important discoveries made in the theory of magnetism in the course of the last two or three years, and we shall discuss some of these; but in order to appreciate them it will be well to begin with a description of the general magnetic

properties of matter. All magnets can be typified by the ordinary bar magnet, which has a north pole at one end and an equally strong south pole at the other. If such a magnet is cut in half, the north half grows a south pole at the section and vice versa. In consequence of this we do not take the magnetic pole as the working

¹ Discourse delivered at the Royal Institution on Friday, May 15

unit, but the magnetic dipole. We imagine that each molecule of the bar has north and south poles, and that they are ranged end to end, so that all the middle ones cancel out and leave a free north pole at one end and a free south at the other. The measure of a magnet is then taken, not as the pole strength, but as the *magnetic moment*, which is the product of the pole strength into the length. The moment of the whole bar is the sum of the moments of its molecules.

There are two chief ways in which magnetic effects exhibit themselves. The first is that shown by a compass when it twists round so as to point along the direction of the earth's field. There is another effect which is very important, and to be distinguished from it, which arises when the field is not uniform. Then one end of the magnet will be pulled more than the other is pushed, and so the magnet will experience a force moving it bodily—this may be either an attraction or a repulsion. The first effect is usually easier to exhibit, but we shall be more concerned with the second.

Under the influence of a magnet all bodies become themselves magnetic, but there are three quite distinct types of behaviour. A piece of iron becomes strongly magnetic with a south pole next the north pole of the inducing magnet. Iron, nickel, and one or two other substances have this property to a high degree, but there are many others, for example aluminium, which show it feebly. For all these it is about a hundred-millionth less, and so a different name is used. Iron, etc., are said to be ferro-magnetic, the rest are called para-magnetic. If a paramagnetic rod is put between the poles of an electro-magnet, it becomes itself a feeble magnet with north pole next to the south pole of the inducing magnet. There exist many other substances, for example copper, having the opposite property. Facing the north pole of the electro-magnet there appears a feeble north pole. This property is called diamagnetism. The measure of the two properties is called *susceptibility*, and is positive for paramagnetic and negative for diamagnetic substances. It is found by making experiments in non-uniform fields. A paramagnetic substance tends to move into the strong field, a diamagnetic out of it. So a bar hung between pointed pole pieces will twist round towards the points in the first case and away from them in the second.

Magnetic action is exhibited by electric currents, as is typified by the galvanometer and every ordinary electrical measuring instrument. Now, in science one cannot admit that two radically different things can produce identical effects, so we are forced to conclude that either the current is really a magnet, or the magnet is really a current, and the second is certainly the correct alternative. In each iron atom there is a current circulating, and this current gives rise to its magnetic moment. We shall see now how this explains dia- and para-magnetism, taking for simplicity the supposition that we are dealing with a gas.

Suppose that we surround a cylinder of metal by a wire and then send a current through the wire. The current causes a magnetic field along the axis. At the moment of making, an eddy current will be induced in the cylinder in the opposite direction, but the frictional resistance to the flow of electricity will destroy this quickly. But if there were no friction (as is actually the case at very low temperatures) this

current would persist indefinitely, and would exert a magnetic field weakening the other. This is exactly what diamagnetism does. So we say that the atom is something like a frictionless conductor. When a field is put on it induces opposing currents in the atoms, and these persist and exert a field opposing the external field.

We must next explain paramagnetism. We believe that every atom has the induced current of diamagnetism, but that this is overridden by a second property. Each atom of a paramagnetic gas has a magnetic moment, even when there is no field. If we could suppose them to be little bar magnets, they would swing to and fro in the presence of an external field, and would be oftener pointing down the field than up it. This would give an extra magnetic moment down the field and would be paramagnetism. Unfortunately the matter is not so simple as this, because the moment must be caused by a revolving electron, and this behaves quite differently. It may be likened to a top, which has the property of always moving at right angles to the direction in which it is pulled. So our atom will not go towards the field at all but will precess round it, and there will be no gain of magnetic moment in the direction of the field. In order to get this gain we have to allow for collisions between the atoms, for then the axes of the tops will be able to change, and will, in fact, have the tendency to point oftener towards than away from the field. The amount of the effect may outweigh the diamagnetism which is always present. The phenomenon shows a clear sign that it depends on collisions, for whereas diamagnetism is constant, paramagnetism depends on the temperature. When the gas is hot, the violence of the collisions makes nearly as many molecules point away as towards the field, but when it is cold the gentle collisions allow them nearly all to settle down along the field.

There is a most difficult point in the argument which is rather too abstruse to explain in detail. It turns on the proper way of taking the averages of the moments of the atoms. This must be carried out with the greatest rigour from dynamical principles. In the past many writers tried to make short cuts and obtained a variety of results. Some proved there could be no paramagnetism, some no diamagnetism, and some even that there could be neither. The essential point of the argument is that the atom must have somewhere the property of a top, which goes on spinning at the same rate however its axis may be altered. It must, so to speak, be able to remember for an indefinite length of time how it behaved when the field was first put on. At least that is how the matter stands on the classical theory. But, as we shall see later, there is definite experimental evidence which shows that the atom is only allowed to exist in a certain very limited number of states, and this rather eases the difficulty; for it need no longer remember its past history, but instead must conform to a rule, unexplained it is true, but in general conformity with other unexplained properties of matter.

The question arises as to whether there would be any way of observing the magnetic moment directly. Such a way was suggested by Stern about three years ago, and the experiment which he carried out in conjunction with Gerlach is certainly one of the most remarkable

of the present century. In a vacuum an atom of gas will go in a perfectly straight line until it hits the wall. If a source of atoms is in line with two fine slits, they will all hit the opposite wall in a narrow line. The atoms were obtained by boiling silver in a small furnace. Those which get through the slits strike the wall and stick there. Even after four hours nothing is visible on the glass, but there exist chemical methods of development whereby the invisible trace of silver attracts more silver from the developer and becomes visible. Now suppose that in their path the atoms encounter a non-uniform magnetic field. In the gaseous form the atoms of silver have a magnetic moment, and so they will experience a deflecting force. If the atoms were pointing arbitrarily in all directions, the character of the field shows that the fine line of the image should be spread out into a lens-shaped figure. What is in fact observed is quite different; the lens is there but it is hollow. The atoms are all pointing straight towards or straight away from the magnetic field.

This result would have been astonishing twenty years ago, but as a matter of fact the experiment was tried with a fairly strong expectation that it would turn out as it did. The quantum theory has illuminated many branches of physics, but none more than spectroscopy, and in particular it describes with complete success the influence of magnetic fields on spectra. According to this theory the atom is a very definite structure, and the definiteness extends not merely to size and shape, but also to its direction in space. The theory goes further and indicates that an atom ought to have a definite magnetic moment, which is called the "Bohr magneton," or in some cases a simple multiple or fraction of this. In silver the deflexion corresponds exactly to one magneton. Several other substances have since been measured, and most of the effects explain themselves on the same principles. Modern physical theory has to face a great many difficulties, and one of the severest is to explain how it is that half the atoms can point away from the field. Each atom evaporates in the furnace right outside the magnetic field and pointing in an arbitrary direction. As it enters the field, if it is to point away, it must gain energy, and there is nowhere from which the energy can come. This would have been a severe difficulty a few years ago, but dynamical toleration has grown recently, and it is becoming recognised as a probability that energy is only conserved on the average and not exactly.

The older calculations of para- and dia-magnetism depend essentially on assuming that the atoms can

point in any direction, and they go wrong if this ceases to be true. We know it to be untrue in Gerlach's experiments, and the question arises as to whether it is true in other cases. This is the subject of some very remarkable recent experiments by Glaser. The susceptibility of gases is very small and hard to measure unless the gases are compressed. Glaser has perfected the arrangements of one method of experiment to such a high degree that he could measure the effect for very low pressures. The principle of his experiment can be described by analogy with the question of buoyancy. If a body is weighed in air and in water, the difference of the weights measures the weight of the displaced water. If a different liquid is used, a similar weighing will give its density in terms of water. Glaser takes a light rod of some substance, actually a slightly paramagnetic glass, and suspends it in a non-uniform field. In a vacuum the field twists the rod round by a definite amount. If it is surrounded by a gas which is also paramagnetic, it will not experience so great a twist, because it will, so to speak, be partly floated by the gas. Similarly, if the gas is diamagnetic, it will be more twisted than in a vacuum. The effect is very small and by no means easy to obtain, but by measuring the amount of twist a value can be found for the susceptibility. The diamagnetism stays constant down to a fairly low pressure, and then changes over to a larger value—actually three times as great. The work is very recent, and the theory is still more or less unknown. Superficially the phenomenon is rather like that of Gerlach, but a little deeper consideration shows that no very close analogy can be drawn between the two cases.

It is natural to suppose that the collisions between the molecules are somehow responsible for reducing the susceptibility at high pressures; but there is great difficulty in seeing how it comes about, for it must be remembered that even at high pressures a molecule is in collision for only a small fraction of the time it spends between collisions. Moreover, though it might be possible to explain in this way a change of susceptibility, there seems no chance of getting a factor so great as three to one. No doubt there will soon be more experiments to help us. For example, much could be deduced if we knew how the curves varied for different temperatures; and it would also be most interesting to know how other gases behave, in particular the strongly paramagnetic oxygen. Unlike the work of Stern and Gerlach, Glaser's experiments do not seem to fit in with the general scheme of things, and so we may perhaps hope that they will lead to some surprising new developments in physical theory.

Obituary.

MR. W. E. CUTLER.

WE regret to have to record the death, on August 30, of Mr W. E. Cutler, the field palæontologist who was working in Tanganyika Territory for the British Museum on the Dinosaur-bearing beds near Lindi. Those who lead sheltered lives in Europe are sometimes apt to overlook the arduous character of the work on expeditions in tropical or arctic lands, where either endemic disease or extremes of temperature endanger human life, and we may venture to refer to an article in these columns on April 18, p. 573, of this

year, in which it was pointed out that the region in which these wonderful relics of an ancient fauna exist is pest-ridden to an unusual degree.

Mr. Cutler was a Londoner by birth, but emigrated to Canada with his parents at an early age. As a young man he became attracted by fossil collecting, and for some time it is believed worked in that wonderful natural museum which exists in Wyoming; later on he made some fine collections from the Cretaceous beds of Alberta and elsewhere. He served with the Canadian forces during the War, and then returned to

his adopted land to make collections for the University of Manitoba from the Ordovician beds of western Canada. He was about fifty years of age at the time of his death. He lived solely for his work, and had in the intervals of his collecting learnt a great deal about the anatomy of the creatures he sought for.

Brought up in a hard school, Cutler prided himself on going anywhere with a minimum of kit and the simplest of food, and it came as somewhat of a shock to him when he was equipped for the East African Expedition to find that his impedimenta contained tents, camp beds, mosquito nets and the like. He was impatient of such things, and inclined to look upon them as unnecessary luxuries which would need attention and therefore hinder his work. Maybe if he had more fully recognised the danger of the insidious *Anopheles*, he would have been spared to carry on his work.

Cutler's labours have been productive of fruitful results, and it is said that more than 600 bones have been collected, some of which have arrived, others being ready for despatch, and it will give some idea of the magnitude of the task when we learn that they will fill at least 120 cases. All these have been personally excavated and prepared for despatch by Mr Cutler with the help of a few untutored natives—no mean task! They have, of course, not yet been worked out systematically, but it has been determined that bones of both armoured and probably carnivorous dinosaurs as well as herbivorous species are among the specimens. Such an enthusiastic worker will be hard to replace, but the work must go on, for what has been achieved

only demonstrates the magnitude of the task and its importance. May this sad loss in the front line stimulate the public to support the expedition and enable it to continue with a staff much strengthened and supplied with every safeguard which the science of tropical hygiene can provide.

C. W. H.

WE regret to announce the following deaths:

Dr. Hans Bunte, emeritus professor of the Technical Highschool in Karlsruhe, well known for his work in connexion with the German gas industry, on August 17, aged seventy-seven years.

Prof. Ernst Erdmann, director since 1922 of the Institute for Applied Chemistry at Halle, on August 19, at Rättvik, Sweden, aged sixty-eight years.

Prof. Georg Klien, director for more than forty years of the East Prussian Agricultural Institute, in Königsberg, on June 23, aged seventy-six years.

Prof. Otto Lummer, director of the Physical Institute of the University of Breslau, whose investigations dealt with interference phenomena and with the estimation of the sun's temperature, on July 7, aged sixty-five years.

Dr. Rudolf Martin, professor of anthropology in the University of Munich and an honorary fellow of the Royal Anthropological Institute, on July 11, aged sixty-one years.

Dr. Mansfield Merriman, professor of civil engineering at Lehigh University from 1878 until 1907, who was a pioneer in the development of technical education in the United States and also was distinguished for his work on mechanics and strength of materials, on June 6, aged seventy-seven years.

Current Topics and Events.

SIR DANIEL HALL, in the course of his presidential address to the Conference of Delegates of Corresponding Societies at the Southampton Meeting of the British Association, appealed for their help in studying the antiquities of the land and of farming. He pointed out that the opportunities in local societies for the study of natural history and archaeology are rapidly becoming smaller, and even in such fields as botany and zoology the development of science is rapidly decreasing the sphere of activity available to the non-professional man. He therefore suggested that such individuals can profitably turn their attention towards recovering, before it is too late, the detailed agricultural history of the country. The Corresponding Societies can give invaluable help in discovering the original settlement of the land, the manors, the system of cultivation adopted before enclosure, and the date and method of enclosure. The need for this work has been made all the more urgent by the Law of Property (Amendment) Act of 1924, which practically does away with the manor as a legal entity, and by the recent sales and breaking up of many of the great estates. Title deeds and estate records in the hands of manor stewards, family solicitors and the like, may therefore become distributed and increasingly difficult to trace. In this connexion a request from a Society to be allowed to examine these records will carry far more weight than one from a private person. In addition, much

useful information could be obtained in some districts by a close study of vestigial physical traces of the old farming, and by the examination of field names referring, for example, to crops that have now disappeared. Again, the preservation for local museums of old farming implements would be a valuable activity of a local society. Apart from the intrinsic interest of this work, it would find a useful and highly desirable application in country schools. A series of parish maps showing the change in agricultural customs, distribution of land, vegetation, and so on, would provide excellent material for showing how, in response to physical and changing economic environments, the present farming system has slowly grown up from its simple beginning far back in the past.

AMONG the interesting exhibits shown in Section B (Chemistry) during the session devoted to the ignition of gases at the recent meeting of the British Association at Southampton were the photographs taken at Sheffield by Prof. Wheeler and Mr. O. Ellis on behalf of the Safety in Mines Research Board. By arranging a camera to open at regular short intervals, they have been able to photograph the successive positions occupied by flames produced by the firing of explosive mixtures of methane and air in closed spherical and cylindrical vessels. When the gas was fired by a spark in the centre of a glass sphere, the successive

images of the flame can be seen advancing uniformly so that the flame reaches the boundary simultaneously at all points; except for very slow flames, the effect of convection currents is inappreciable. Some of the photographs, first exposed when the flame had reached the walls of the vessel, show not only the ring of light outlining the circular image of the sphere, but also a re-illumination spreading outwards from the centre of the sphere. This after-burning affords a neat proof that the chemical action is not completed by the apparent passage of the flame through an explosive mixture. The illumination is due to pressure-waves reflected from the spherical surface meeting at the centre, and increasing the rate of the residual combustion. The phenomenon may be compared with the intense reflected waves sent back from the closed ends of short narrow tubes when the explosion-wave has not quite time to develop before the flame reaches the ends. Other photographs were shown in which the flames were started at the top, the bottom, and the side of the sphere. Such asymmetric ignition results in a retardation of the development of pressure and a lower maximum pressure compared with central ignition. When the gas was ignited in a cylinder, the flame progresses regularly until it touches the walls, then it appears to be squeezed slowly into the corners. The photographs have been reproduced in *Fuel in Science and Practice*, 1925, 4, 356.

THE Southampton meeting of the British Association came to an end on Wednesday, September 2, with a meeting of the General Committee, at which votes of thanks were passed to the mayor and corporation, local committee, officers, and all who had contributed to its success by their support and hospitality. At the meeting of the General Committee held on August 28, a deputation from Leeds attended to invite the Association to hold its meeting there in 1927, and the invitation was cordially accepted. The date of the Oxford meeting next year, at which the Prince of Wales will be president, is to be August 4-11. The following vice-presidents of the Association nominated from Oxford for the Oxford meeting have been appointed: The Chancellor of the University the Vice-Chancellor of the University, the Mayor of Oxford, the Lord Lieutenant of Oxfordshire, the Bishop of Oxford, the Dean of Christ Church, Sir Charles Sherrington, Lord Valentia, Dr. Gilbert C. Bourne, Dr. G. Claridge Druce, Prof. E. B. Poulton, Mrs. G. H. Morrell, Sir Arthur Evans, Prof. H. H. Turner, and the Principal of University College, Reading. The local officers for the meeting are: *Treasurer*, Mr. B. Rowland Jones; *Secretaries*, Dr. F. A. Dixey and Brigadier-Gen. H. B. Hartley. The new members of Council of the Association are: Prof. A. L. Bowley, Dr. H. H. Dale, Sir Richard Gregory, Prof. T. P. Nunn, and Prof. A. O. Rankine.

POPULAR interest in natural history is on the alert. The records of museums, popular lectures, public libraries, press articles and natural history publications generally, even the upshoot of the "fundamentalists," all show that interest has been aroused

in life and its workings. Here are evidences which the man of science cannot afford to ignore, for a widespread knowledge of the methods and discoveries of science must result in a fuller appreciation of scientific method and in the formation of a mass opinion which will thrust new power into the hands of the scientific worker. But the position also demands that science in its popular presentation shall be progressive. The day of the simple chronicle of the obvious has passed, and it is needful that the plain man should learn something of the more profound relationships and interpretations which now engage the investigator. Further, the people cannot safely be left to gain their impressions of the aims and conquests of science from the cheap trifles of the dilettante; the simple rendition of the subtleties of modern research, whether it be in the written word or in the museum exhibit, demands the application of the trained and fully stored mind.

BECAUSE of these things "The New Natural History," by Prof. J. Arthur Thomson (London: George Newnes, Ltd., 1925. To be completed in about 20 fortnightly parts, 1s. 3d. net each part), deserves a warm welcome. The first part, which has recently been received, suggests that the work is to take the form of a series of short unrelated essays dealing with various aspects of the manifestation of life: in the present 43 pages are compressed brief accounts under the headings of man's relations with other living creatures, the web of life, animal behaviour, the ways of monkeys, the beauty of life, the story of the bower-bird, everywhere there are fitnesses, everything in the light of its history, the hand of the past. In view of Prof. Thomson's own previous work and of the best popular natural history of the present day, the treatment is not strikingly "new," but it is new in the sense that it discards the stilted systematics of the past and emphasises the trend of modern zoology towards a fuller appreciation of the biological significances of structure, habit, and development. The work is to be completed in about twenty fortnightly parts. Should it share the success which met the earlier "Outline of Science" in Great Britain and in the United States it will exercise a wide influence in moulding popular knowledge of the attainments of scientific investigation of animate nature.

THE fourth autumn lecture to the Institute of Metals was delivered on September 1 by Sir John Dewrance on "Education, Research, and Standardisation." Using the word "education" in its broader meaning of education of the human race, Sir John emphasised the superiority of scientific method and of wisdom over mere knowledge, and asked for greater appreciation of those who have discovered new truths and made them available to mankind. Men with original minds should be spared from the necessity of earning a living by doing inferior work, but private benefactions for the furtherance of research being still inadequate, although increasing, the assistance of the State is imperative. After reviewing the main activities of the Department of Scientific and Industrial Research, and, in particular, those of the

National Physical Laboratory, Sir John Dewrance discussed the meanings of the words research, discovery, and invention, pointing out how closely they are interwoven, and urging a wide acceptance of "research" so as to include such activities as the designing of a new type of submarine, or the devising of a new method of production in a factory

WITH regard to the use by Sir John Dewrance of the word "research" to cover historical studies, it may be pointed out that the business of the historian is not, strictly speaking, to discover new facts but to resurrect old. It is true that he uses the scientific method and, like the investigator of Nature, frames views or hypotheses to correlate observations and immediate inferences from them, but in view of the circumstance that, although his interpretation may be new, his facts are necessarily old, there is a distinct difference between them and creative scientific research. Sir John Dewrance proceeded to describe the enormous amount of work involved in devising standards. The British Engineering Standards Association, formed in 1901, is controlled by a main committee which presides over 400 sub-committees of engineers and other experts who give their labour gratuitously; and it is pleasing to hear that in a recent letter the Prime Minister expressed his appreciation of the valuable work done by the Association and his confidence in the application of its methods to the study of production costs, which is one of the most pressing industrial problems of the day. In Sir John Dewrance's view, the character of virtue is best seen in the life of an intellectual man devoted to the service of truth. The status of the discoverer and research worker is being gradually raised, and he hoped that his lecture would hasten progress. "All who have benefited by knowledge should feel it a duty to do something for the acquisition of further knowledge"

IN the early hours of September 3, the great United States airship *Shenandoah* was destroyed by a storm which broke the vessel into three pieces. The *Shenandoah* was noteworthy in that its gas-cells were filled with helium instead of hydrogen, and details of its structure were given in an article in NATURE of March 1, 1924, p. 313. It would appear that on September 3 the airship was travelling at an altitude of about 3000 ft. near Cambridge, Ohio, and according to a telegram to the U.S. Navy Department by Commander C. E. Rosendahl, the senior surviving officer of the airship, a mild storm was followed by a sudden line squall which caused enormous and uncontrollable angle strains and a rapid vertical ascent. This resulted in the ship's structure breaking when it got to a height of about 7000 ft. It is suggested in a message from the New York correspondent of the *Times* that the sudden rise of the airship caused undue expansion of the helium containers, straining the strut wires and girders and cracking the framework. Capt. Anton Heinen is quoted as stating that the disaster was indeed due to this cause, and that the number of safety-valves in the *Shenandoah* were

insufficient to permit of the rapid release of gas necessary when a sudden ascent is made

THE following Royal Commission has been appointed to inquire into and report upon the economic position of the coal industry in Great Britain and the conditions affecting it, and to make any recommendations for the improvement thereof: Sir Herbert Samuel (chairman), recently High Commissioner in Palestine, Sir William Beveridge, Director of the London School of Economics, General the Hon. Sir Herbert Alexander Lawrence, a managing partner of Glyn, Mills, Currie and Co., and Mr. Kenneth Lee, chairman of the British Cotton Industry Research Association and of Messrs. Tootal Broadhurst Lee and Co., Manchester. The following are to act as expert assessors: Mr. William Brace, Chief Labour Adviser to the Mines Department, Dr. Walcot Gibson, formerly of the Scottish office of the Geological Survey of Great Britain, Major H. M. Hudspeth, one of H.M. Divisional Inspectors of Mines, and Dr. C. H. Lander, Director of Fuel Research, Department of Scientific and Industrial Research. The secretary of the Commission is Mr. C. S. Hurst, Assistant Under-Secretary, Mines Department.

A PROVISIONAL programme has been issued of the second conference of the Association of Special Libraries and Information Bureaux to be held at Balliol College, Oxford, on September 25-28. The first session will be opened by Dr. R. S. Hutton, chairman of the conference, who will describe the present position of the Association, and in the general discussion which is to follow, Mr. A. E. Twentyman and Prof. F. E. Sandbach will speak. On the following day, the morning session will be divided between two discussions, on the special library movement in America and the Institut Internationale de Bibliographie, Brussels, respectively, while the afternoon will be devoted to papers on abstracting, cataloguing, indexing and filing. A discussion in the evening will show the relation of special libraries and information bureaux to the Press. Meetings will be held on Sunday, September 27, in the morning and evening, at which the relation of special libraries to patents, science, medicine, education, transport and other aspects of modern life will be discussed.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: The Dutton memorial professorship of entomology in the University of Liverpool—The Registrar, The University, Liverpool (October 1). Two chemists at the Naval Ordnance Inspection Centre, Holton Heath, Dorset—The Secretary of the Admiralty (C.E.), Whitehall, S.W.1. A biologist at the Kirton Agricultural Institute, Boston, Lincs.—The Principal. A cancer research worker at the Radium Institute—J. C. Mottram, Research Laboratories, The Radium Institute, 16 Riding House Street, W.1. Lecturer in mechanical engineering—Agent-General for Western Australia, Savoy House, Strand, London, W.C.2.

Research Items.

THE MAYAN CALENDAR.—An interesting contribution to the discussion of the calendar of the ancient inhabitants of Central America and its possible correlation with Christian chronology is made by Mr. J. E. S. Thompson in *Man* for August. Spinden, in his new scheme of correlation, has made the Mayan New Year Day fall on the winter solstice, which he says was arbitrarily chosen to initiate the calendar. But the names of the Mayan months appear to contradict his theory. Although data relating to the annual routine in agriculture of the pre-Spanish Maya are absent, it is justifiable, in view of their innate conservatism, to assume that modern Mayan customs give a fairly clear idea of the routine of their ancestors. When the agricultural operations are taken month by month, it is found that each of these is faithfully represented by the names of the month in the calendar. For example, in December and January the virgin bush is cut down, the scrub is left to dry until May, when it is burnt, whereupon the Mayans leave their villages to take up their residence in their *Mulpas* (allotments). Then come the heavy, late spring rains, softening the ground, and sowing follows. In the Mayan calendar as given by Landa, *Mol* corresponds to December 12, meaning to pile or collect together, i.e. the brushwood was piled. *Ceh* or *Cel*—roasted, March 2, refers either to the burning of the brushwood or the condition of the soil after drought. *Muan*, May,—showery. *Pax* (May-June), to take possession, referring to the removal to the *Milpas*, and so on. Any correlation which does not conform to the naming of the months, such as Spinden's in making *Cumhu*, the sowing season, and *Pop*, maize leaves, mid-winter instead of June and July, must be rejected.

PALÆOLITHIC MAN IN MORAVIA.—The third instalment of the Abbé Breuil's survey of palæolithic sites in Central Europe which appears in Pt. 3-4 of Vol. 35 of *L'Anthropologie* deals with the Moravian caves, of which the most important are Kostelík and Kulna. At Kostelík, which is in the neighbourhood of Brno, the fauna is that of the mammoth and the reindeer. Notwithstanding the absence of stratigraphical evidence, some of the stone implements can be attributed with some certainty to the Acheulean-Mousterian; others belong to the Aurignacian and beginning of the Solutrean; others again are of a generalised upper palæolithic type and are to be assigned with some probability to the Magdalenian. Certain remarkable objects made from the jawbones of horses, which have been described ineptly as carvings representing fish, are in reality a kind of ornamented knife in which the curved part of the jaw without teeth has been utilised to form a handle. Both sides of the blade and handle are closely covered with an ornamentation of parallel curved lines alternating with short strokes and big dots. In some cases they are combined to form a very simple decorative motif, such as a group of chevrons, while in one case this may be a sketch of an animal's head. The remainder of the bone implements are Magdalenian, probably of various periods. A postscript describes a small statuette of a mammoth in clay found near Untertarnitz in 1924.

EYE FATIGUE.—In the *Journal of the Franklin Institute* (August 1925), Mr. Percy W. Cobb and Mr. Frank K. Moss give the results of some experimental work on eye fatigue in its relation to light and work. The problem of lighting is one of outstanding importance in industrial work; when work can be performed by daylight the problems are relatively simple, but as soon as artificial light has to be used

new factors intervene. With the higher intensities of illumination people are apt to complain of eye fatigue. The laboratory experiments described in this article were an attempt to study the effect produced by visual operations under different intensities of illumination. An ingenious test was devised as a means of fatiguing the eye—and incidentally the attention—and the effect of the different intensities was measured by comparing the changes in the muscle balance of the subject before and after the test. The test itself, worked for 30 minutes, did affect the muscle balance significantly, but the change in the intensity of the illumination showed no significant difference either with regard to the amount of work done or the effect on the eye. The conclusion, though, cannot be expressed by the general statement that the higher intensity was in no way harmful or tiring to the eyes of the worker; all that can be said is that, under these conditions, no appreciable effect could be observed. The eye fatigue cannot be estimated apart from the effect of attention, and industrial conditions introduce still more complications.

INSECTS OF THE SWISS NATIONAL PARK.—Volume 60 (1924) of the *Denkschriften* of the Swiss Natural Science Society, consists entirely of the second and third instalments of the results obtained under the Commission appointed by the Society for the study of the fauna of the Swiss National Park in the Lower Engadine. The Hemiptera and the Collembola are dealt with in the volume before us. Dr. Hofmann began his special investigation in 1918 in company with Dr. R. Menzel, but lost that valuable colleague on his being called away for special entomological work in Java. His account of the Swiss Hemiptera deals with the Heteroptera and the Cicadine group of the Homoptera. Including previous records, and not adhering strictly to the confines of the National Park, he finds the list of Heteroptera to comprise 113 genera, 181 species and 6 varieties, while the Cicadinae number 81 species and 15 varieties distributed among 28 genera. The most interesting conclusion arrived at is that the Hemiptera of the Lower Engadine are somewhat southern in character, and have a marked affinity with the fauna of the South Tyrol. Dr. Handschin's researches into the Collembola of the National Park have been very fruitful. He adds to the list of 65 hitherto recorded Swiss species no fewer than 30 species, of which 7 are new to science. Moreover, the abundance of his material has enabled him to show that several forms regarded as specifically distinct are in reality only colour variants. Thus he is led to suppress *Entomobrya lanuginosa* and *E. nicoleli* with its two varieties *muscorum* and *obscura*, all of which he finds to belong to the very variable species *E. nivalis*. Both authors give full details of horizontal and vertical distribution, and the plates are adequate. Altogether this instalment of the results of the Commission forms a handsome volume.

THE COLEOPTEROUS FAMILY BRENTHIDÆ.—*Indian Forest Records* (Entomology Series), vol. 11, Part iv., 1925, is devoted to studies on some Indian beetles of the family Brenthidæ. Herr Richard Kleine describes a number of new genera and species from British India and the neighbouring regions, bringing up the total number of known members of the family to 240 species. Dr. C. F. C. Beeson contributes an article on the biology of the family and its relations to forestry. This paper is the most important yet published on the subject and adds very considerably to what little was previously known. The family is divisible into two

groups—(a) phytophagous, and (b) myrmecophilous, the latter only containing a few species. As regards group (a) Dr. Beeson's observations suggest that the Indian species (at any rate) are true wood-borers in the larval state and that their habitat is normally in felled or fallen timber and not in living trees. The adult beetles occur gregariously between the bark and wood of trees that have been attacked by bark and sapwood-boring larvæ (mainly Longicornia). The myrmecophilous species include symphylines living in association with ants, while others are robbers. Mr. J. C. M. Gardner describes the larvæ of two species of Cerobates and the pupa of *Cyphagogus corporaalii* Kleine. The larvæ show characters common to the Rhynchophora, e.g. their curved form, the vestigial antennæ, the continuity of the mentum and prothoracic cuticle, etc. The presence of evident though minute thoracic legs is not incompatible with these affinities since many curculionid larvæ exhibit reduced ambulatory tubercles.

INDIAN LIMNÆIDÆ.—The last memoir from the hand of the late Dr. Annandale forms a revision of the recent Indian Limnæidæ, in which H. S. Rao collaborated (Records Indian Museum, vol. 27, Part 3, May 1925). The authors have offered this paper as a means of identifying the species of Limnæa found in the Indian Empire. They have had the advantage of studying the largest collection of shells and of material preserved in spirit ever accumulated from any oriental country, and they have had good opportunities of noting the range of variation. They discuss the characters of the jaws, radulæ, shell, and genitalia, and after concisely describing 21 species and their "forms," they provide a tabular key to the living species known from the Indian Empire and its immediate frontiers and a table of measurements of their shells. In Part 1 of the same volume is an obituary notice of Dr. Annandale and a list of his publications, which occupies 21 pages; it indicates the extraordinary range of his interests and the activity of his mind and his pen.

THE BOGHEAD COALS.—The United States Geological Survey has published an interesting paper (Professional Paper 132-I), by Reinhardt Theissen, on the origin of the Boghead coals. This paper is a careful study of that group of coals which passes into true coal on one hand and into shale on the other, including, therefore, the substances usually spoken of as bituminous shales, oil shales, cannel coals, etc. The author shows that the yellow bodies characteristic of boghead coals are algæ of a somewhat unusual form; the name *Elæophyton* has been suggested for this organism, and its structure has been worked out in considerable detail. The paper is all the more interesting because it is practically contemporaneous with the work by Prof. Jeffrey of Harvard University, lately noticed in these columns, who discusses these bodies at considerable length, and proves quite definitely to his own satisfaction that the bodies in question are spores and not algæ. It is, however, clear that Prof. Jeffrey knew nothing of Mr. Theissen's work.

INDIAN METEOROLOGY.—The meteorology of India was dealt with by Sir Gilbert T. Walker, professor of meteorology, Imperial College of Science and Technology, in a paper read at the Royal Society of Arts on May 8, and published in the Society's Journal of July 31. As Sir Gilbert was chief of the Meteorological Department in India for more than twenty years, and until quite recently, many points of considerable interest were referred to. The characteristic feature of the south-west monsoon is

explained, and the three weeks' journey of the air over the sea before it reaches India is said to afford time for air dry at its origin to become saturated with moisture to a considerable height, which is necessary to supply such rainfalls of 30 to 40 inches in a day, which occur in the western ghats and the corresponding hills near the Burma coast, combined with moderately heavy rain inland. Work carried on for the last forty years by Blanford and Eliot, and later by the author of the paper, with the view of forecasting the monsoon rains by the assistance of data in various parts of the globe, is explained. The difference between the air motions producing abundant and scanty rainfall is associated with marked differences in the conditions over a large part of the earth's surface. Abundant Indian rains are associated with low pressure in India, Java, Australia, and South Africa, and with high pressure in the Central Pacific and South America. The warning for storms at sea is assiduously carried out, and warnings are issued of the danger of sunstroke or heat apoplexy when the wet bulb temperature approaches 85° F.

A LABORATORY OZONISER.—A laboratory ozoniser, capable of yielding high concentrations of ozone (15 per cent.), is described by L. I. Smith in the July issue of the Journal of the American Chemical Society. The capacity of the ozoniser is more than 4 gm. of ozone per hour. The apparatus consists of three modified Brodie tubes, made of soft glass, connected in series and mounted in a large battery jar. All connexions which come in contact with ozone are arranged so as to be made through mercury seals. The battery jar is filled with distilled water, and serves both as an electrode and for cooling purposes. Owing to the high voltage used (about 8000) the resistance of the water is negligible, and thus there is almost no heating effect; a metallic cooling coil, however, is also immersed in the jar. The electrode inside the tube consists of mercury. Some observations on the action of various reagents on ozone are also recorded. These fall into two groups: (1) substances having only a very small effect, e.g. water, concentrated sulphuric acid, phosphorus pentoxide resublimed in oxygen, and (2) those having a great effect, destroying much or all of the ozone, such as ordinary phosphorus pentoxide and 5 per cent. sodium hydroxide solution.

DECOMPOSITION OF SULPHURYL CHLORIDE.—A paper by D. F. Smith in the July issue of the Journal of the American Chemical Society records some observations on the thermal decomposition of sulphuryl chloride. This is a first-order homogeneous gas reaction. Only one other such reaction is known, namely, the thermal decomposition of nitrogen pentoxide, investigated by Daniels and Johnston (1921). The data obtained for sulphuryl chloride fit the theoretical equations put forward by Trautz and Bhandarkar (1919). No theory of reaction rate yet proposed, however, fits in with the observations made in both of these reactions, so that none of these theories is of general application.

HYDROBROMIC ACID IN ACIDIMETRY.—The composition of an aqueous hydrochloric acid solution which boils at a constant temperature is sufficiently definite to permit its use as a standard solution in acidimetry (Hulett and Bonner, 1909). D. T. Ewing and H. A. Shadduck have published a paper in the Journal of the American Chemical Society for July, showing that hydrobromic acid solutions may be used for the same purpose. The constant-boiling acid boils at about 125° (760 mm.) and is 5.9061 N by weight. It contains 47.795 per cent. HBr.

Mosquito Control.

OPENING OF A NEW INSTITUTE AT HAYLING ISLAND.

A NEW phase in the control of the mosquito problem was reached last week when members of the Section of Zoology of the British Association attended the opening of the British Mosquito Control Institute, which has been founded and equipped by Mr. J. F. Marshall in his own grounds at Hayling Island, Hants.

The new building (Fig. 1) occupies two stories and includes a demonstration museum, a laboratory, drawing and record offices, photographic rooms, a library, and a mechanical workshop. There are also a number of smaller rooms designed for research students. It already contains a wealth of material for mosquito study not available elsewhere, and historical records of how the mosquito has been successfully combated on the island.

The formal opening, which took place on Monday, August 31, was presided over by Sir Richard Gregory, chairman of the Council of the new Institute. As a result of the preventive work undertaken, which has

consisted largely of draining the inter-tidal areas, Hayling Island, which formerly was infested with "salt-marsh" mosquitoes, has now been practically cleared. In introducing the subject, the chairman pointed out that in many parts of the world the question was whether the

mosquito or man should survive. It was, he said, one of the glories of British science that much of its best work had been done by men who were not professional workers but had studied Nature simply because of the desire to gain knowledge, and without any ulterior motive. Mr. Marshall had been responsible for work of that kind, and the result of it was the building that was about to be opened, the British Mosquito Control Institute.

Sir Ronald Ross, in opening the Institute, described his own experiences at Hayling Island some three years ago. He had, he admitted, been sceptical as to the accusations made against *Ochlerotatus detritus*, the salt-water mosquito. Mr. Marshall, however, had convinced him by taking him to a part of his garden and inviting him to observe the insects flying about in broad daylight. In the course of his observations, Mr. Marshall had proved his point by directing his attention to the fact that three of the insects were simultaneously extracting blood from the back of his neck. Sir Ronald Ross pointed out that when he began work on the mosquito there was not a book or a good article dealing with the mosquitoes in India. Much is now known, but, in addition to knowledge, energy is necessary for acting upon it. What has been done in the Panama, at Ismailia, and in the Federated Malay States is only a beginning. He insisted on the importance of controlling not only the

mosquitoes but also all those dangerous and unpleasant pests that prey on man and on his crops and herds. It is ridiculous that while man dominates the earth, the sea and the air, he should continue to be the prey of bacilli and even die from such contemptible things as colds in the head and mosquito bites. Improved medical and sanitary science and administration have, in the last eighty years, increased the average length of human life in Great Britain by about fifty per cent., yet men still die of many diseases which will one day be conquered. Sir Ronald Ross pleaded for the expenditure of a million pounds a year on medical research so as to accelerate the conquest of disease. Such a sum would be trivial compared with the money now spent on tobacco, alcohol, and entertainment, without taking into account what is spent on education, armaments, and the "dole." While the work of the new Institute is to be general rather than medical, it will unquestionably

keep the sanitary applications of mosquito control within range of its vision. The knowledge gained in the Institute will facilitate mosquito control in every region of the earth, and it is certain that the day will come when the fertile tracts now ravaged by king Malaria and king Mosquito will

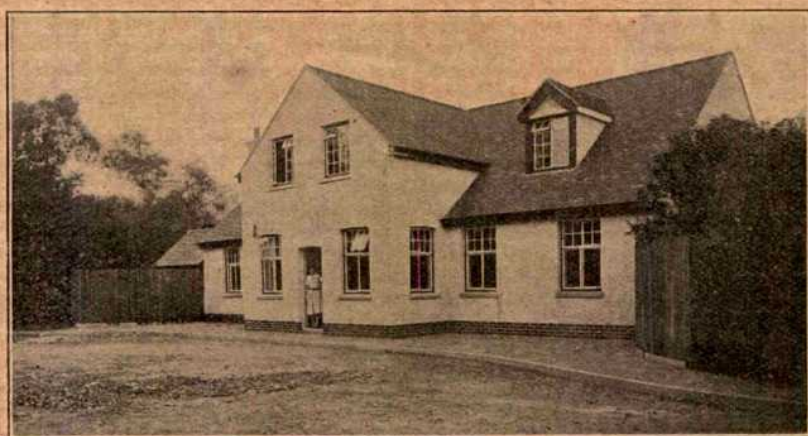


FIG. 1.—The British Mosquito Control Institute.

be laid open to civilisation. This happy result will, however, only be attained by more thought, by more research, and by a firmer determination to make the most of the beautiful world in which we live.

A vote of thanks to Mr. Marshall was proposed by Mr. C. Tate Regan and seconded by Col. James, of the Medical Department of the Ministry of Health. The Ministry, he said, greatly appreciates the good work done by Mr. Marshall. Col. James emphasised the importance of voluntary assistance given to the Government, and said that it is on this that the success of public health administration largely depends. He promised on behalf of the Ministry that it would watch the working of the Institute with great and, he hoped, helpful interest.

The ceremony concluded with a few words of thanks from Mr. Marshall, and it was announced that the composition of the Council of the Institute is as follows:—Major E. E. Austen, Dr. Andrew Balfour, Mr. F. Balfour-Browne, Sir James Crichton-Browne, Dr. H. Eltringham, Sir Richard Gregory, Col. S. P. James, Dr. G. A. K. Marshall, Prof. H. Maxwell Lefroy, Prof. E. B. Poulton, Sir Ronald Ross, Dr. Hugh Scott, Sir Arthur E. Shipley, Prof. Sir William Simpson, and Dr. C. M. Wenyon. The Trustees are Sir Richard Gregory and Mr. L. W. North Hickley, and the honorary director, Mr. J. F. Marshall.

Glutathione.

THE isolation by Hopkins of glutathione, the dipeptide of cysteine and glutaminic acid, was a definite advance in our knowledge of the processes of oxidation and reduction in living cells. The compound was found to exist in two forms, the reduced and the oxidised; the latter consists of two molecules of the former united by means of the sulphur atoms of their cysteine portions after the loss of two atoms of hydrogen. The oxidised form thus acts as a "hydrogen-acceptor"; in the reoxidation of this reduced form it is probable that active oxygen is set free for oxidation processes in the cell, oxygen also acting as the "hydrogen-acceptor"; whether the compound was present in the oxidised or reduced form seemed to depend largely on the hydrogen-ion concentration. It was suggested by Quastel, Stewart and Tunncliffe that the dipeptide was formed by the linkage of the amino group of cysteine to that carboxyl group of glutaminic acid which is furthest away from its amino group; they based their conclusion on a study of the breakdown of the molecule in various directions.

Stewart and Tunncliffe have now confirmed this view by preparing glutathione synthetically and finding it identical with the natural product (*Biochem. Journ.*, 1925, vol. 19, p. 207). Two methods were employed: in the first, glutaminic acid was converted to hydantoinpropionic acid, and the latter then converted to the acid bromide with phosphorus tribromide and coupled with cystine dimethyl ester hydrochloride. The hydantoin ring was opened by boiling with calcium hydroxide, and the resulting compound, probably a uramino-acid, converted to the dipeptide by treatment with nitrous acid in slight excess of the amount necessary to remove one nitrogen atom. The dipeptide was isolated from the products of the reaction by means of the mercuric sulphate compound. The glutathione formed agreed with the natural product in all its properties except that its rotatory power was considerably less. This is probably due to racemisation during the formation and opening of the hydantoin ring. This result led the authors to their second method of synthesis: by acting directly on glutaminic acid with phosphorus tribromide, the acid bromide was formed in which the bromine replaced the hydroxyl group in the carboxyl furthest from the amino group. The acid bromide was coupled with cystine dimethyl ester and the glutathione isolated as in the previous method. The compound was found to be completely identical with the natural glutathione.

The amounts of the dipeptide occurring in tissues are very small; quantitative determination by actual isolation of the substance can only lead to approximate results owing to the losses which are bound to occur. Tunncliffe has elaborated a method which is both quicker and probably more accurate (*Biochem. Journ.*, 1925, vol. 19, p. 194). The tissue is ground with sand and 10 per cent. trichloroacetic acid and filtered. The filtrate is titrated with $N/100$ iodine solution, the reduced form of glutathione being thereby oxidised. The end-point is judged by the use of sodium nitroprusside as an external indicator, with which the reduced glutathione forms a purplish colour. The method estimates the —SH groups in the extract: glutathione is the only known substance present which will give the reaction, since there is no evidence that cysteine exists in the free state in the tissues normally. Most of the glutathione appears to be present as the reduced form in the cells. Skeletal muscle of the rat or rabbit contains about 0.03 to 0.04 per cent., and liver 0.2 to 0.25 per cent.; yeast

contains about the same percentage as liver; it is completely absent from blood. The values obtained thus are three to five times greater than the amounts actually isolated.

The product obtained from tissues has been found to contain small quantities of iron: Harrison has determined its amount and obtained a value of 0.6 per cent. (*Biochem. Journ.*, 1924, vol. 18, p. 1009). Now the reduced form of glutathione undergoes spontaneous oxidation in air; recognising that iron frequently acts as a catalyst in oxidations, Harrison prepared a pure glutathione and examined its rate of oxidation in air. The uptake of oxygen was much slower than in the case of the impure preparation: the author considers that this may be due to traces of catalysts which have escaped removal. As with the impure compound, cyanides inhibit this uptake of oxygen, probably by forming a compound with the iron.

The oxygen uptake in these cases, including that of pure glutathione, is a linear function of the time over a large part of the course of the reaction: this is probably due to the fact that the rate of oxidation depends on the amount of dissociated ionised iron present; the sulphhydryl group can lose its hydrogen more quickly than oxygen can be prepared to receive it. Increasing amounts of cyanide decrease the rate of oxidation by decreasing the amount of ionised iron present. On the other hand, when relatively large quantities of iron are available the rate of oxygen uptake decreases continuously, since excess of active oxygen is present throughout and the amount of the sulphhydryl compound becomes the limiting factor and its concentration progressively decreases with its oxidation.

The inhibiting effect of cyanide is less marked in the presence of organic iron, for example hæmatin, and in correspondence with this, Harrison has found that cyanide has a less marked effect in reducing the oxygen uptake of glutathione in the presence of a thermostable preparation of muscle tissue, which has the power of reducing the oxidised form of glutathione to the sulphhydryl compound.

Further light has been thrown on the mechanism of the action of glutathione in the oxidation processes of tissues by some recent experiments by Tunncliffe (*Biochem. Journ.*, 1925, vol. 19, p. 199). The reduction of the oxidised form by the tissue preparation in the absence of oxygen is rapid for the first three hours and complete in about five hours: only a certain quantity can be reduced by any given tissue preparation, this amount being the measure of the labile hydrogen of the tissue. The same tissue will reduce a similar quantity of methylene blue. The nature of the buffer salts and the reaction of the medium have no influence on this reduction. On the other hand, the reverse change, the oxidation of reduced glutathione, proceeds more rapidly in a slightly alkaline medium than in an acid medium. In the presence of oxygen, the tissue will reduce the glutathione, which will forthwith become oxidised again and the process will only cease with exhaustion of the labile hydrogen of the tissue or of the oxygen supply.

If, however, the amount of oxygen actually taken up is measured, it will be found to exceed considerably that necessary to oxidise the reduced glutathione formed by the tissue: the excess is considerably greater in the absence of phosphate ions. Hence concurrently with the oxidation of the glutathione, oxidation of some other substance must be taking place, and Tunncliffe considers it probable that this is of the

nature of an unsaturated fatty acid, since Meyerhof has shown that the oxidation of linolenic acid is accelerated by the simultaneous oxidation of a sulphhydryl group present at the same time. Thus the oxidation of the fatty acid depends on the presence of the reduced glutathione, which in turn is formed by

the "hydrogen donators" of the tissues. When oxygen acts as a "hydrogen-acceptor," removing the hydrogen from the reduced glutathione which is thereby oxidised, part of the oxygen becomes activated and available for the oxidation of other substances present in the cell.

The Royal Observatory, Edinburgh, and Accurate Measurements of Time.

THE record of the work done in 1924 at the Royal Observatory, Edinburgh, recorded in the annual report of the Astronomer Royal for Scotland, Prof. R. A. Sampson, is of supreme importance to those interested in the accurate measurement of time.

For some years Edinburgh has taken the lead in this subject, and Prof. Sampson's papers before the Royal Society of Edinburgh and the Royal Astronomical Society on the performance of his clocks have been followed with keen interest in the observatories of the world. His three first-grade clocks are the Riefler No. 258, which, we understand, is one of the best turned out by the famous Munich firm; Leroy No. 1230, which is a duplicate of those at the Paris Observatory used in connexion with the time transmission from the Eiffel Tower; and Shortt No. 0, the original Free Pendulum of the Synchronome Co.

By means of an oscillograph and micro-chronograph, which resembles a cinematograph camera, Prof. Sampson's clocks are in effect *put under a microscope*, that is to say, their performance is observed and automatically recorded each day to an accuracy of one thousandth part of a second, a method which Prof. Sampson says "rarely fails to show when one or other of them has changed rate by as much as .01 sec." The daily comparison, he continues, demonstrated a decided superiority in the rate of clock Shortt; indeed the other two were scarcely able to serve as a check upon it. Therefore, with the view of carrying time work to the limit that the appliances will allow, a second model of the clock (Shortt No. 4) was installed in January in one of the vacant clock cells in the basement. The connexions for temperature control are the same as in the other cells. The original clock of these series (Shortt No. 0) which was erected here for trial by Mr. Shortt in 1923, and has shown such remarkable going, has been generously presented to the Observatory by the Synchronome Company Limited, in association with whom Mr. Shortt had prepared his model. Briefly, it may be said the only discernible faults in the going of Shortt No. 0 are a small temperature coefficient showing when an accident disturbs the temperature control of the cell, and a minute leak in the case, which has not been located.

Prof. Sampson's investigations in recent years have

focussed attention upon the lack of precision in transit observations, upon which, of course, all time determinations are based. Instrumental errors in the transit circle telescope have always been carefully measured and allowed for. They take a prominent part in the somewhat complex process of smoothing the clock rates. In the race for accuracy, the precision of the clock and of the means of comparison by wireless time signals have outrun the precision of transit observations.

Radio telegraphy has enabled distant observatories to compare their times with great precision, thanks to the rhythmic signals or "time-vernier," and they are found to disagree by amounts which, though they may appear trivial to a layman, are of considerable importance in an exact science such as astronomy. Astronomers have indeed been considerably perturbed at their lack of agreement, and Prof. Sampson had set himself the task of searching for the cause of the error which has been found to occur in time determinations at all observatories.

Prof. Sampson now makes the definite statement that "owing to improvements in the clock and chronograph system in this Observatory, and in receiving apparatus for W.T. signals from other observatories, it has proved possible to bring this investigation to an issue. It has been found that during the whole of 1924 the whole of the large erratic or systematic errors are removed if the level error, determined as usual by the mercury bath, is rejected, and the observations reduced instead by an azimuth error derived from one of the collimators, in combination with the usual observations of polar stars. The implications of this result are of high interest and importance to astronomers and will be pursued."

Referring later to his automatic records of the numerous W.T. signals, Prof. Sampson says, "the comparison of time determined at this observatory with the same determined elsewhere exhibits features of the sub-systematic character that had been noted in previous years, though each observatory had cleared its determinations of all known errors. As remarked above, the source of these discrepancies appears now to be located, at least so far as the observatory is concerned."

F. H.-J.

World Meteorology and Long-range Forecasting.¹

THE possibility of seasonal forecasts in India was first investigated by H. F. Blanford about 1876, using only the snowfall in the Himalayas. As the research proceeded, it was found necessary to consider conditions farther and farther away, until in the hands of Sir Gilbert Walker it developed into an investigation of the inter-relationships of weather in all parts of the world. A chart of the average barometric pressure over the globe shows a number of more or less permanent areas of high and low pressure; for example, the Azores high and the Icelandic low. In these areas the variability of pressure reaches a

maximum, and they are accordingly termed "centres of action"; the pressure changes of intervening places, such as the British Isles, are dominated by those at the centres of action.

Sir Gilbert Walker has realised that these "strategic points" offered the best chances for an attack on the problem of long-range weather forecasting, and has studied in great detail the relations between twenty different centres of action. In "Correlation in Seasonal Variations of Weather," Part 8 (Memoirs of the Indian Meteorological Department), published in 1923, he laid down the groundwork of a theory of world weather and outlined the mechanism by which variations in one part of the world are transmitted to other parts of the world a few months later. The

¹ "A Further Study of World-Weather. Applications to Seasonal Forecasting in India." By Sir G. T. Walker. (Memoirs of the Indian Meteorological Department, vol. 24, Parts 9 and 10.)

problem is, however, too complex for a sufficiently complete theoretical solution to be possible at present, and the only method is the patient comparison of the pressure variations in each centre of action with the subsequent variations in all twenty centres. This laborious research has been carried out, and the results are presented in Part 9, "A Further Study of World Weather." The quarterly means are compared with those for two quarters before, one quarter before, the same quarter and one and two quarters after, at all stations—some 4000 correlation coefficients in all. From these coefficients 189 relationships are found which are probably significant according to the author's rigid standard, and are of value for seasonal forecasts either six months or three months ahead.

The consistency of the relationships is very remarkable, and "supports the view that seasonal forecasting is capable of wider application than at present." Most of the significant relationships discovered are between the different tropical and sub-tropical centres, at which weather abnormalities usually persist for several months, and the research indicates possibilities for the initiation or improvement of seasonal forecasting in such regions. For countries within the temperate storm belts, such as the British Isles, the outlook is not so hopeful; the significant correlation coefficients are fewer and smaller, and the fluctuations from month to month are often so great that the value of a general three-monthly forecast is limited. The final solution of the problem of long-range forecasting in temperate latitudes will undoubtedly have to take account of world-relationships, but only as giving a general tendency to the weather, the fluctuations of shorter period being determined by other and more local causes.

In Part 10 Sir Gilbert Walker returns to the original purpose of these studies and gives an example of the application of the results to seasonal forecasting in India. From the closest relationships found between rainfall in India and the preceding conditions in other parts of the world, greatly improved formulæ are deduced for forecasting the monsoon rainfall of different districts and the winter precipitation of the Himalayan region. The formulæ impress one very strongly with the meteorological unity of the world, that for Peninsula rain, for example, depending on the preceding conditions in such widely scattered regions as Alaska, South America, and Rhodesia. The statistical basis is sufficiently complete for the forecasts to be made confidently; and while in the story of Indian forecasting, begun fifty years ago, the final chapter is not yet written, we may reasonably believe that the main lines of the plot have been laid bare.

University and Educational Intelligence.

IN the course of an address delivered on September 4 at the opening of a new secondary school at Preston Lodge, East Lothian, Lord Balfour made some noteworthy remarks on the relation of schools to universities and on the importance of research in pure science. If the university is compelled to act the part either of the primary or secondary school its work is hampered, its utility diminished, and its wheels clogged. The purpose of the secondary school is, however, not merely to prepare students for the university, but rather to give an education by means of which those who are unable to go to the university can face life without feeling seriously handicapped. Referring to the importance of the practical teaching of science, Lord Balfour said he was glad to learn that science is to form a prominent part of the curriculum of the new school, and that it is to be taught by laboratory demonstration and experiments. "In-

dustry in the future," he said, "must be based upon science." If industrialists imagine that science can be built up without a disinterested love of knowledge, they fall "into the most grievous blunder." The multiplication of subjects in modern secondary and university education and the specialisation it entails are regarded by some as disastrous to the progress of education and the highest interests of culture and learning. Lord Balfour stated that, if the dangers of specialisation are kept in view, they can be reduced to a minimum, and the necessary flexibility, variety, and complexity of modern education successfully maintained.

THE Geographical Association has been experimenting for some time in the matter of conducted educational tours for teachers under the direction of volunteer experts. Some teachers and members of several universities joined a group of honours students in geography, of the University College of Wales, Aberystwyth, at Easter, in a tour around France, under the direction of Miss S. Harris, of the staff of that College. At the beginning of August, two groups left England to study the Alps, one the western Alps, starting from Chamonix, and one the eastern Alps, starting from Innsbruck. They were under the leadership, respectively, of Mr. J. I. Platt and Miss S. Harris, both of the University College of Wales, Aberystwyth. Among their objects was the demonstration of the newer views of earth history, and especially of mountain building, to which MM. Argand and Staub have given expression in the last few years. The charabanc has made it possible for teachers to intensify their knowledge of Britain, and tours have been organised to various natural regions of England, and to North and Central Wales, to demonstrate structural and general physical features with particular reference to the ways in which these factors have affected settlement, industries and communications. These tours were organised under the leadership of Messrs. E. E. Lupton and V. C. Spary. The Tours Committee of the Geographical Association would like to experiment further by specialising on selected regions for more intensive study if a sufficient number of members and intending members care to take part. All communications, concerning tours should be sent to the honorary secretary of the Tours Committee, Mr. E. E. Lupton, 73 Bierley Lane, Bradford.

THE Institute of Intellectual Co-operation, of which the governing body is the League of Nations Committee on Intellectual Co-operation, presided over by a French member of the Committee, is expected to open its doors towards the end of the year. The directorate of the Institute is composed of the following members: M. Bergson, M. de Reynold, Prof. Lorentz, Prof. Gilbert Murray, and Senator Ruffini. The Director is M. Julien Luchaire, Inspector-General of Education in France. The budget for 1926 amounts to 2,100,000 French francs, two millions of which represent the grant made by the French Government and 100,000 that of the Polish Government. The Committee at its meeting of July 27-30 approved of the adoption of an international students' card as recommended by the International Students' Federation. It took note of a memo by Dr. Hagberg Wright, Director of the London Library, on the subject of the international borrowing of books, and recommended a series of practical measures for facilitating such loans. It considered also questions relating to intellectual property, an international meteorological bureau, an international university for the training of statesmen, journalists and others, the unification of scientific nomenclature, and a loan for the development of intellectual life.

Early Science at Oxford.

September 16, 1684. Dr Plot began reading his discourse *de Origine Fontium*; half of which being read, we proceeded to other matters.

A letter from Dr Pit was read, which promises his discourse concerning Digestion; and gives an account of a woman, who, by reason of stoppages for three monthes, complained of a load, and fullness of her stomach; vomited blood, flesh, and blood-vessels, as big as goose quills, after which, by ye help of some Physick, she recovered.

A Letter from Mr Molyneux, dated Dublin September ye 2nd, 1684, was read: It gave an account, that Mr Osburn had observed ye last solar Eclipse near Tredagh in Ireland, lat: 53°. 40'. Initium H. 1.37' 30". finis H 3.56' 20".

Merchant Wayt's account of his peice of Incombustible Cloth was read

A Letter, written at ye Request of this Society, by Mr President, to be sent to ye head of each of the Universities in Scotland, for the establishing a Correspondence in that Kingdom, was read

Sir Robert Sibbald's *Scozia Illustrata*, was presented ye Society

Dr. Mark, an ingenious Brandenburg Gentleman, was proposed, in order to be elected a member of this Society

September 23, 1684. Dr. Plot continued ye reading of his discourse *de Origine Fontium*, and severall other things were offered to ye Society, but ye company being very small, they were referred to another meeting

September 30, 1684. Dr. Plot made an end of reading his Discourse *de Origine Fontium*, after which, ye Society gave him their thanks, for communicating to them so succinct an account, of what has been delivered by other writers, and of his own observations, on this subject; and also made it their request, that he would be pleased to print ye same.

A letter from Mr Aston, dated September ye 25th, was read; in it were contained some observations of ye late solar Eclipse taken by severall French astronomers, and printed in ye *Journal des sçavans*. They are translated into English, and will suddenly be printed in ye Transactions

Part of a Letter from Dr Cole of Worcester, dated September ye 27th, was read, which informed the Society, how very ready that learned physitian is to correspond with us, and to communicate to us, whatsoever shall occur to him fit to be imparted

Dr. Plot communicated an old silver ring, lately found in Staffordshire, with this motto, *in Godt al*; and an old Roman brass ring gilt about two ounces, 3 drams in weight, sent him by Mr. Packer, Physitian at Reading; this ring had a cornelian set in it, and four collets round ye cornelian, for as many stones more, three of which were lost.

A large stone, consisting of severall Branches, taken out of ye kidney of a woman by Mr Packer, was communicated by Mr Westead. An Account of this Stone will be printed in a little time.

Spongia arborescens erythraformis, i.e. of ye forme of Samphire, from Devonshire; and some of the button berries, from Jamaica; as also some Kelp, embroydered with ye shells of fish growing on ye leaves of that plant, (all which are a part of that present the generous Mr. Cole of Bristol lately made this University), were communicated to us by Dr. Plot.

Dr Caspar Marck having been proposed, Sept: 16th, his admission was now put to the Ballot, and carried in ye affirmative, after which he subscribed to the Articles.

Societies and Academies.

LONDON.

Institute of Metals (Autumn Meeting, Glasgow), September 3.—Robert J. Anderson and Everett G. Fahiman: The effect of low-temperature heating on the release of internal stress in brass tubes. The work was carried out to determine a suitable heat-treatment which would prevent warping of manufactures made of lead-brass tubing on standing for a period at the ordinary temperature, and at the same time effect stress release without material loss in hardness and strength. Heating for 2 or 3 hours at 325° C or for 4 hours at 300° C. in the case of material reduced 22 ½ per cent in area is satisfactory, but the mill control of separate lots of tubing must be substantially identical if a given heat-treatment procedure is to be applied to the material.—L. H. Callendar: Passivation and scale resistance in relation to the corrosion of aluminium alloys. Aluminium is a passive metal; its normal reactions are modified by the presence of a hydroxide scale of high mechanical, chemical, and electrical resistance. Corrosion in water may be started by solution or peptisation of this scale, it may be stopped by precipitation of scale on the metal surface. Chlorides reduce the resistance and adherence of these scales, and carbonates tend to increase scale resistance. Nitrates passify the metal by direct oxidation and anodic polarisation. Dichromates combine the passifying action of nitrates with the formation of a highly resistant scale containing chromate.—O. W. Ellis: The influence of pouring temperature and mould temperature on the properties of a lead-base antifriction alloy. Within the limits of the experiments, the replacement of lead by antimony increases the resistance to compression and increases the hardness. The replacement of tin by copper increases the resistance to compression but scarcely affects the hardness. Mould temperatures are more important than pouring temperatures. There is evidence of an intermetallic reaction in the copper-bearing alloy in the liquid state at 334° C.—R. H. Greaves and J. A. Jones: The effect of temperature on the behaviour of metals and alloys in the notched-bar impact test. Copper, aluminium, and lead showed a continuous fall in impact figure from -80° C. to the melting-point. Maxima in the impact figure-temperature curves were shown by tin at 0°, zinc at 150°, duralumin at 400°, lead-free 70:30 brass at 800°, 60:40 brass at 715°, 10 per cent aluminium bronze at about 750° C. On the other hand, 70:30 brass containing 0.02 per cent. or more of lead, and coinage bronze, showed no similar improvement in impact figure at high temperatures. A high notched-bar impact figure seems to indicate good rolling properties; for many alloys there is a range of temperature within which their behaviour on rolling is likely to be worse than at either higher or lower temperatures.—D. Hanson and Marie L. V. Gayler: On the constitution of alloys of aluminium, copper, and zinc.—Harry Hyman: The properties of some aluminium alloys. Aluminium alloys available for sand castings for engineering purposes generally possess low ductility, and this renders them difficult to manipulate in workshop practice; also they are readily susceptible to corrosion. A series of alloys was prepared with the view of passing a minimum test of 5 tons yield point, 10 tons breaking stress, and 5 per cent. elongation on sand-cast test-bars, and at the same time capable of undergoing a severe salt spray corrosion test without marked loss in weight. The alloy B.S.7, containing copper, nickel, iron, and magnesium, gave the most promising results, and has

been adopted on a commercial scale.—Douglas H. Ingall: The high temperature-tensile curve: (a) Effect of rate of heating; (b) Tensile curves of some brasses. For any given load the breaking temperature and the critical inflection temperature are lower the slower the rate of heating. In the lower temperature, straight-line portion of the curve, the relationship between breaking temperature and rate of heating may follow a hyperbolic curve, which would establish a definite fundamental tensile strength for any given temperature. Alloying increases the number of loops in the higher temperature curve over a given range of temperature, this is probably due to space lattice distortion. The high temperature-tensile curves of the brasses indicate that the solution of zinc in copper, over the α -range of composition, is not simple.—George B. Phillips: The primitive copper industry of America. There was a pre-historic copper industry in America, carried on by aborigines, who made widespread use of copper for tools, weapons, implements, ornaments, and ceremonial objects. This extensive manufacture of copper implements of similar shape to take the place of the stone and bone articles formerly used seems to justify the claim of a primitive copper culture for the American Indians, suddenly interrupted by the arrival of the Spaniards.—D. Stockdale: The α -phase boundary in the copper-tin system. Specimens were brought into equilibrium by quenching from a high temperature followed by long heat treatments at the supposed temperatures of the transformations. At ordinary temperatures the solubility of tin in copper is much higher than any previous diagram indicates; it is 16.0 per cent. of tin by weight. This result does not affect bronze-bearing metals, because such material when originally cast consists of the α and δ phases, and the hard δ shows no tendency to dissolve in the soft α at low temperatures. The existence of a transformation in the β phase has been confirmed.

PARIS.

Academy of Sciences, July 27.—Henri Jumelle: The tombak tobacco of the Alaonites.—Alexandre Rajchman: Multiple convergence.—Th. Vautier: Secondary waves due to an aerial wave.—Nobuo Yamada: The long-range particles emitted by the active deposit from radium.—André Graire: The theoretical and practical conditions of reversibility of the reactions in the leaden chamber process.—Muncunari Tanaka: The quinonediazides of the anthraquinone series.—G. Vavon and P. Peignier: The preparation of active isoborneol. Two methods have been worked out and are described in detail, one starting with pinene hydrochloride, the other by the catalytic hydrogenation of camphor.—E. Rothé: The earthquake of February 22, 1924, in the Pyrenees. Discussion on the epicentre.—Gabriel: The application to meteorology of the astronomical cycle of 744 years.—Mlle. G. Bonne: The retrogression bundles in the floral section of certain Rosaceae.—Ad. Davy de Virville: The effect of hygrometric state and of submersion on the form and structure of mosses.—Antonin Němec and Mihovil Gračanin: The influence of the reaction of the soil on the absorption of phosphorus and potassium in the presence of various phosphatic manures.—R. Hovasse: The Ellobiopsidæ, propagated by flagellispores.—J. Dumas, G. Ramon, and Said Bilal: The immunising properties of dysenteric anatoxin.

SYDNEY.

Linnean Society of New South Wales, June 24.—J. R. Eyer and A. J. Turner: The Australian species of *Oncopera* (Hepialidæ, Lepidoptera). A key to

the species is given, based on the characters of the male genitalia, as well as a key to the superficial characters. Two species are described as new, making four species in all in the genus.—A. B. Walkom: Fossil plants from the Narrabeen stage of the Hawkesbury Series. Near the base of the stage, a few species have been found representing a survival of the *Glossopteris* flora. Higher up, the flora is quite distinct from the *Glossopteris* flora, and about twenty species are known. No description of this flora has been published hitherto.—A. Eland Shaw: New genera and species (mostly Australasian) of Blattidæ, with notes, and some remarks on Tepper's types. Notes are given on many of Tepper's types in the South Australian Museum. Four genera and twenty-five species are described as new, and an attempt has been made to explain some of the peculiarities of structure in the *Panesthinae* most strongly evidenced in the earth-digging group.

Official Publications Received.

- Proceedings of the American Academy of Arts and Sciences. Vol. 60, No. 2: New Researches on the Magnetization of Ferromagnetic Substances by Rotation and the Nature of the Elementary Magnet. By S. J. Barnett and L. J. H. Barnett. Pp. 125-216. (Boston, Mass.) 1.50 dollars.
- Bulletin of the Geological Institution of the University of Upsala. Edited by H. Sjogren. Vol. 17. Pp. vi+450+11 plates. Vol. 19. Pp. iii+249+8 plates. (Upsala: Almqvist and Wiksells Boktryckeri A.-B.)
- University of Colorado Bulletin. Vol. 25, No. 6, General Series No. 219. Catalogue, 1924-1925; with Announcements for 1925-1926. Pp. 394. (Boulder, Colo.)
- Imperial Economic Committee. Report of the Imperial Economic Committee on Marketing and Preparing for Market of Foodstuffs produced in the Overseas Parts of the Empire. First Report: General. (Cmd. 2498.) Pp. 38. (London: H.M. Stationery Office.) 9d. net.
- Lawes Agricultural Trust, Rothamsted Experimental Station, Harpenden. Report 1923-24, with the Supplement to the "Guide to the Experimental Plots" containing the Yields per Acre, etc. Pp. 130. (Harpenden, Herts.) 2s. 6d.
- Anatomical Society of Great Britain and Ireland. Proceedings, May 1921-February 1925. Recorded by R. J. Gladstone, edited by B. Barclay-Smith. Pp. 120. (London: Cambridge University Press.) 12s. 6d. net.
- Bulletin of the National Research Council. Vol. 9, Part 3, No. 60: Bibliography of Bibliographies on Chemistry and Chemical Technology, 1900-1924. Compiled by Clarence J. West and D. D. Berolzheimer. (Washington, D.C.: National Academy of Sciences.)
- National Association of Master Bakers, Confectioners and Caterers. Report on Research at the National Bakery School, London. By Dr. G. Dorée and J. Kirkland. Pp. 27+10 plates. (London: Regent House, Kingsway.) 2s. 6d.
- Indian Forest Records. (Economy Series), Vol. 11, Part 9: Summary of Investigations on Bamboos and Grasses for Paper Pulp. By W. Hatt. Pp. ii+11+1 plate. (Calcutta: Government of India Central Publication Branch.) 8 annas; 9d.
- Imperial Economic Committee. Report of the Imperial Economic Committee on Marketing and Preparing for Market of Foodstuffs produced in the Overseas Parts of the Empire. Second Report: Meat. (Cmd. 2440.) Pp. 35. (London: H.M. Stationery Office.) 9d. net.
- Scientific Papers of the Institute of Physical and Chemical Research, Tokyo. Vol. 3, No. 32: On the Physical and Chemical Properties of Biosterin (a Name given to Fat-Soluble A) and on its Physiological Significance. By K. Takahashi, Z. Nakamiya, K. Kawakami and T. Kitasato. Pp. 81-146. Vol. 3, No. 33: Condensation of Nitriles with Thiamides, V. Action of Sulphur Monochloride upon Thiamides. By S. Ishikawa. Pp. 147-154. Vol. 3, No. 34: On the Behaviour of some Spark Lines of Carbon in an Electric Field. By S. Nakamura and Y. Fujioka. Pp. 155-162. Vol. 3, Nos. 35-36: A new Discussion of Bucherer's Experiment; On the Interpretation of the Results of Bucherer's Experiment. By U. Doi. Pp. 163-182. (Tokyo.)
- Union of South Africa. Department of Mines and Industries: Geological Survey. Cape Sheet No. 5: Laingsburg. The Geology of the Country near Laingsburg: Explanation to Cape Sheet No. 5. By Dr. A. W. Rogers. Pp. 84. (Pretoria: Government Printing and Stationery Office.) 2s. 6d. net.
- Report of the Aeronautical Research Committee for the Year 1924-25. Pp. 44. (London: H.M. Stationery Office.) 1s. 6d. net.
- Aeronautical Research Committee. Reports and Memoranda No. 956 (Ae. 174): The Airflow round a Body as affecting Aircraft Performance. By C. N. H. Lock, H. Bateman, and H. C. H. Townsend. Pp. 22. 1s. 3d. net. Reports and Memoranda No. 969 (Ae. 186): A Note on the Katzmayer Effect, That is, The Effect on the Characteristics of an Aerofoil produced by an Oscillating Airstream. By W. L. Cowley. Pp. 5. 6d. net. (London: H.M. Stationery Office.)
- University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1924. Pp. 135. (Bristol.)
- Department of Industries, Madras. Report for the Year ended 31 March 1924. Pp. iv+89. (Madras: Government Press.) 6 annas.
- Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Kitts-Nevis, 1923-24. Pp. iv+39. (Barbados.) 6d.



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The Future of the British Patent Office.

IN the issue of NATURE for February 7 of the present year, we dwelt at some length upon the qualifications which were called for in the head of the British Patent Office, and concluded that the responsibilities of the Office were such that the staff should be presided over by a man eminent in science. The interest which our remarks aroused, combined with the passing of time when a new official in the ordinary course of events will be appointed, lead us again to refer to the same subject and to emphasise the importance of the position occupied by a Comptroller-General of Patents and the desirability for the post to be allotted to one in whom discoverers, inventors, scientific workers, manufacturers, and lawyers would have confidence.

As we have already pointed out in our former article, the duties of a Comptroller are multifarious. Apart from those in which science, industry, and law occupy so great a part, there are many duties referable to clerical management—which, very properly, may be assigned to a subordinate. With these duties, however, we are not here concerned. We desire rather to consider some special aspects which we trust will be present in the minds of those who in due course will be called upon to select the individual best fitted to perform the functions inherent in one of the important offices in the State.

Under the Patent Law Amendment Act of 1852, down to January 1884, the granting of patents was in the hands of the Commissioners of Patents, among whom were the Lord Chancellor and the Master of the Rolls. During that period, therefore, the department was almost entirely of a legal character and only remotely associated with the manufacturing classes. When the Patents Act of 1884 came into operation—now superseded by other Acts—the Patent Office was created and its functions transferred to the Board of Trade, in the control of which the Office has continued to the present day. At the same time, in 1884, a body of examiners was created, composed of persons who, by their training, were qualified in the various branches of industry and science in which they had had experience. By a further section of the Patents Act a Comptroller-General was appointed head of the Patent Office.

Since January 1884 three Comptrollers have successively held office. Without in any way attempting to depreciate the great abilities which have been shown by these Comptrollers in their respective spheres, we may say that none has held high position at the Bar, or has been in close touch with the manufacturing interests of the community, or has been distinguished in scientific circles. Each appears to have been content to be strictly "official." Some may perhaps see in this the truly distinctive British policy of "muddling

through," a policy which, however successful in the past, is not necessarily bound to serve in the future. But a policy such as this is by no means compulsory; on the want of a suitable candidate being known, there would be found many whose qualifications are of the highest who would be willing to undertake the responsibilities of the post, provided the remuneration offered was commensurate with the duties to be assumed and approached the salary obtainable outside the Civil Service.

It is only fair to remark, however, that the policy since 1883 has resulted in some substantial gain, and that a definite amount of progress has been secured. Thus mention has been made in previous articles of the setting up of a system of a limited search for "novelty" and a publication of abstracts of all specifications. Minor alterations in the law have also brought about the changes which the public has demanded, while the payment of fees, many of which are on a low scale, has been facilitated. But, speaking generally, the Board of Trade has been content to follow some distance behind public opinion and has resisted changes until agreement had been arrived at on all sides. One is almost tempted to say that the pouring into the national revenue of profits from the Patent Office of annual sums exceeding 70,000*l* has had a soporific effect upon the Board of Trade, with the result that stagnation rather than progress has resulted. Now, within a measurable distance of time, the Board will have to appoint a new chief of the Patent Office, and thereby to settle for a considerable period the silent but certain trend of affairs in a department where the interests of all classes of the community meet on a common level.

The same problem which is involved in the selection of the chief of the Patent Office has also presented itself to the Government of the United States of America. It would be well, therefore, to consider for a moment the way in which that problem has there been attacked. In the United States, as in Britain, administration of the Patent Office involves mixed questions of law, science, and technics; and it appears to be the present policy of the U.S. Office, in the first place, not to promote any examiner to the position of Primary Examiner unless he has studied law and become a member of the Bar, it being premised that an examiner before entering the Office has passed a severe examination in science and industry. The Commissioner of Patents is chosen from among the patent lawyers or, in some instances, by the promotion of Assistant Commissioners of Patents who have risen through all the grades in the Office. It is, however, generally understood that neither the Patent Bar nor the industrial interests would tolerate the appointment of a Commissioner who had had neither a scientific education nor extensive experience as a patent lawyer. Custom and public sentiment in the United

States demand that a Commissioner of Patents shall have had large experience in the practice of patent law and either a scientific education or extensive dealing with scientific questions.

Powerful advocacy for a thoroughly efficient Patent Office is to be found in the speech of the Prime Minister when reviewing the nation's position in the debate upon the unemployment question in June last. Mr. Stanley Baldwin said on that occasion that—

"No one will assert that British Industry can be saved by science alone, but it is none the less true that until scientific methods and scientific men can take their place in industry, and an equal place with the administrator and the financier, British trade will never be strong enough or resilient enough to meet the shocks that it is bound to meet as the years go by; to meet the sudden and unexpected changes which will always arise in international trade."

As the *Times* commentator expressed it: "Mr. Baldwin, as a business man himself, knows that there are thousands of people among us who already work up to the limit of their capacity and their strength. But he thinks that many employers by using their brains could add another ten per cent. to the efficiency of their several industries, and he touched briefly on some of the lines on which our conservative methods and practice might be improved."

It is an aim of the patent system to stimulate and assist employers in securing this increase of ten per cent. efficiency. The head of the Patent Office, with the qualifications which we have expressed, might be expected to make his influence felt not only within the narrow limits of his department but also in other regions far removed from bureaucratic control. The cry throughout the country is for increased production. To the discoverer and inventor we must look for a cutting adrift from old contrivances and for the best means and the most expeditious ways of bringing into being those necessities upon which our welfare as individuals and as a nation so much depends. Stimulation to industry and to invention is demanded if the position which the country held in the nineteenth century is to be recovered. A Comptroller-General high in scientific, engineering, and other technological societies, in touch with industrial concerns, and acquainted with the special needs of the various classes of persons to whom the industrial use of inventions is of paramount importance, would know best how to make the Patent Office play an effective part in the furtherance of the general advance.

We have set out in some detail the main qualifications which we think are desirable in a Comptroller of the Patent Office. That there are many in whom these qualifications may be found we have no doubt. There

are some even in the Civil Service who, not having surrendered themselves to the cramping conditions of their environment, could adequately fill the post. It is fairly certain, however, that a greater choice lies to hand outside the ranks of the Service; for, in general, it is more probable that the ideal man has already come to the front in situations where foresight, intelligence, and business capacity, unfettered by artificial restriction and official timidity, have been essential to success.

When such a man has been discovered, we may consider for the moment how his services are to be obtained. What are the inducements for him to leave his present position and to submit to the ruling of the permanent officials under whom the Patent Office is administered? At the end of a quiet and successful domestic career in the Civil Service there awaits the holder of an important position the companionship of an illustrious order with a possible knighthood. In extreme instances a Civil Servant becomes ennobled. In these respects, however, service under the Crown does not differ materially, or for the better, from commercial service. What then are the pecuniary advantages? Apart from security of tenure of office, which of course is a valuable asset, the salary attaching to the Comptrollership is altogether inadequate to attract the class of man who is so eminently desirable. The salary of the Comptroller of Patents is 1500*l.* per annum. To this there must be added a bonus calculated according to the published scale, say a sum of 200*l.*, which makes 1700*l.* in all. It may be said frankly and once for all that for such a sum the man who has given proofs of his ability in other walks of life to conduct the business of the Patent Office upon fitting lines is not to be found. The sum must be increased if the proper man is to be attracted to the post.

The Board of Trade, in conjunction with the Treasury, have the matter in their hands, for it is extremely unlikely that Parliament, which has the final control of salaries, would reject an increase which is shown to be necessary for securing the services of the right man. This selection is not merely a domestic matter which alone concerns officials in the Civil Service; it is one that affects industrialists, whether employers or employed. The issues are serious. Are we content to jog along as of old, making a minimum of progress even if stagnation is not present? Or are we to see assistance rendered in every department of industry, assistance in bringing forward the backward inventor, assistance towards the perfecting of the inventors' schemes and the securing of their best practical forms for immediate use by the public? It is therefore for the Board of Trade at the proper time to show that it is alive to the potentialities that await its selection of the head of the Patent Office.

The World's Scientific Periodicals.

A World List of Scientific Periodicals Published in the Years 1900-1921. Pp. xii+499. (London: Oxford University Press, 1925.) Two volumes, 3*l.* 10*s.* net (in cloth) or 3*l.* 3*s.* net (in paper).

THE "World List of Scientific Periodicals" had its origin in a letter written in 1920 by Sir Sidney F. Harmer, Director of the Natural History Departments of the British Museum, to Dr. P. Chalmers Mitchell. Sir Sidney Harmer asked that the Conjoint Board of Scientific Societies might consider the possibility of preparing a list of the chief scientific periodicals with an indication of the libraries in which these might be consulted. Dr. Chalmers Mitchell at once declared himself a warm advocate of the idea. Indeed, as secretary of the Zoological Society, and an enthusiastic supporter of the "Zoological Record," he had already taken some steps toward the inclusion in the "Record" of some indication of the libraries where the periodicals indexed could be found. Before the War, the Council of the Zoological Society had granted a small sum of money to compile a list of periodicals containing zoological articles, with indication of the libraries in London which had these periodicals on their shelves. This compilation had not been completed when war broke out.

The effort then made showed that the task of drawing up a list to show where each periodical could be consulted was a formidable one. While some periodicals are taken by several libraries, others are only to be found in one or two libraries, and many are not taken by any library in Great Britain. Even when a periodical is subscribed for, it is sometimes found that the series on the shelves is incomplete.

The Executive Committee of the Conjoint Board of Scientific Societies at once adopted Sir Sidney Harmer's suggestion in principle, provided that it should cover all branches of science. A Committee was appointed consisting of Sir Sidney Harmer, Mr. F. W. Clifford, Sir Richard Gregory, Dr. P. Chalmers Mitchell, Dr. A. W. Pollard, and Prof. W. W. Watts. The Committee decided that scientific periodicals in existence from January 1, 1900, should form the list, that the libraries to be indicated as taking in these periodicals should be those in London, Oxford, Cambridge, Edinburgh, Dublin, and Aberystwyth, and that, whenever possible, at least one library in the United Kingdom should be indicated for each title.

The objects of the list were declared to be:

- (1) To supply a list of current scientific periodicals as nearly as possible complete.
- (2) To indicate, where possible, at least one library where each periodical is taken.

(3) To form a basis for co-operation between libraries, so that both the number of duplicates and the list of periodicals not taken in at any centre may be reduced.

(4) To enable any library to use the list for its own purposes, by placing a mark against the title of each periodical it possesses, or by cutting up the pages to prepare a Card Catalogue. The list is accordingly printed only on one side of the paper, so as to make cutting up practical or to afford space for additions and annotations.

The Trustees of the British Museum not only recognised the importance of the enterprise as an aid to scientific research and as a means of increasing the usefulness of the libraries of Great Britain and Ireland, but also, on the recommendation of Dr. Pollard, then Keeper of Printed Books at the British Museum, supported by Sir Frederic Kenyon, Director and Principal Librarian of the Museum, they allowed the compilation of the list to be undertaken by the staff of the Museum as part of their official duties.

It soon became apparent that the magnitude of the work undertaken was such that the cost of preparation and publication could not be covered by subscriptions and sales. At this point, Sir Robert Hadfield and Mr. Robert Mond gave provisional guarantees to enable the work to proceed. The Trustees of the Carnegie United Kingdom Trust then guaranteed the sum of 1000*l.* towards the cost of production, on the condition that the number of centres with important libraries to be dealt with in the list should be greatly increased. This change in the original plan considerably increased the cost of preparation. Early in 1923 the Conjoint Board of Scientific Societies came to an end, but before its dissolution it entrusted "The World List" to Sir Arthur Schuster, Mr. Robert Mond, and Dr. P. Chalmers Mitchell, who undertook to form a company limited by guarantee to complete, own, and conduct the World List. Such a company was duly incorporated with a council of management consisting of Dr. P. Chalmers Mitchell (chairman), Sir Arthur Schuster, and Mr. Robert Mond. Miss Joan B. Procter became secretary. The original Committee was appointed as Advisory Committee, so that, except for the formal change in ownership and responsibility, there was no break in the control.

The actual compilation has been carried out, under the direction of Dr. A. W. Pollard, by Mr. W. A. Smith and Mr. L. A. Sheppard. Mr. Leonard Wharton has helped with the Slavonic entries. The periodicals catalogued are not only those in British libraries, but also all those concerning which information could be obtained from any part of the world.

Very special thanks are due to the Trustees of the British Museum and to the Keeper of Printed Books

for allowing this work to be done by members of the staff of the Museum. It should, however, be mentioned that Dr. Pollard points out that it is only in very exceptional circumstances that any library can undertake to catalogue books not contained within its walls. He therefore suggests that there is a real need for a small "flying squad" of trained cataloguers and bibliographers who would help to make the wealth of books in English libraries available for students.

The actual list now published contains the titles of 24,128 periodicals. This is really a remarkable figure, when it is remembered that the number of periodicals indexed by the International Catalogue of Scientific Literature is only about 9000. In arranging the titles inessential words are disregarded and words regarded as unnecessary are cut out. The care with which these abbreviations have been made is, on the whole, judicious, but it is surely a mistake to change plurals into singulars in all the large headings. The title of the *Comptes rendus* is given as "Compte rendu hebdomadaire des séances de l'Académie des sciences, Paris."

This change from plural to singular is made in order that the periodicals beginning *Compte rendu* may be classified together with those beginning *Comptes rendus*. There are no less than ninety journals beginning with these two words either in the singular or in the plural, and the compilers evidently disliked having one list of journals beginning *Compte rendu* followed by another list beginning *Comptes rendus*. The "World List of Scientific Periodicals" will for a long time be the standard work to which authors will refer when anxious to quote the exact title of a journal. In these circumstances it is desirable that the titles given should be quite accurate in the list, and that any difficulties in classification should be overcome by laying down some general rules such as "In fixing the alphabetical order of the titles indexed, the plural 's' is disregarded." This would be on a par with the plan adopted in Watts's "Dictionary of Chemistry," where the prefixes "bi-," "tri-," etc., are disregarded so that bicarbonates and carbonates may come together.

The volume now published contains a numbered list of scientific periodicals. The scope of the term "scientific" is that laid down in the International Catalogue of Scientific Literature. The present volume does not give indications of the libraries in which the periodicals may be found. A second volume, to be issued shortly, will contain a list of numbers corresponding to the numbers allotted to the titles in this volume, followed by a standard abbreviation of the title and reference letters indicating the libraries filing each periodical.

An exceedingly valuable addendum to the list is a catalogue of international congresses. It is most

necessary that scientific workers should know how to get access to the accounts of papers read and discussions held at these congresses and conferences. Hitherto, there has been nothing approaching a complete list of these publications, still less any indication as to where they can be consulted. Mr. Gomme, of the Patent Office Library, has given much personal attention to the preparation of this catalogue of proceedings at international congresses. All who are interested in the advance of scientific knowledge will be grateful to him for the care he has given to this section.

Our thanks are due to all those who have ungrudgingly given time and thought to the successful working out of this great undertaking, and to those who gave financial assistance when the project seemed likely to fail from lack of funds to carry it on. Dr. P. Chalmers Mitchell, who signs the preface, has evidently been the driving force ready at all times to meet and overcome difficulties as they arose. The task has been great, but those who undertook it have resolutely set themselves to accomplish it and have brought it to a successful issue.

Jungle-Folk of India.

The Birhors. a Little-known Jungle Tribe of Chota Nagpur. By Rai Bahadur Sarat Chandra Roy. Pp. viii+608+36 plates. (Ranchi: *Man in India* Office, 1925.) 10 rupees; 15s

THE Birhors dwell in the jungles which fringe the eastern margin of the great central 2000 ft plateau of Chota Nagpur, in the Province of Bihar and Orissa. Like so many other primitive communities, they seem doomed to perish under the impact of modern life; between 1911 and 1921 their number fell by more than 30 per cent (from 2340 to 1510). Mr Roy's monograph is a timely record of a dying race.

Some of the Birhors are "settled," and eke out a livelihood by burning patches of jungle and raising a scanty crop of maize and beans. But their normal mode of life, to which even settled Birhors often revert, is nomadic; the fauna and flora of the jungle supply them with food and with the *chōp* fibre (*Bauhinia scandens*) which they make into rope and barter for such clothing, condiments, etc., as they cannot produce themselves. The Birhors eat almost anything; whether they ever ate their ancestors, as commonly alleged, is an open question; the case against them is not yet proved.

Racially the Birhors resemble the more virile Mundas and Oraons of Chota Nagpur. Their language is a dialect of that Austric family which straggles round half

the globe, from Madagascar to Easter Island. Their social organisation, as elsewhere in India, is based on clan exogamy, but in the economy of daily life the kin-group yields precedence to the clan-group, or *tāndā*, a word applied also to the encampments of Lambadi (Banjari) gipsies who were once the carriers of peninsular India and the Punjab. The *tāndā* consists of from 3 to 10 families, belonging to various clans, associated together for subsistence. Each *tāndā* has its captain (*nāyā*), its magician (*māti*), and its messenger (*diguār*), its own spirits (*sāngi bhūt*), and its own hunting expeditions. Mr. Roy explains in detail their hunting ritual and the partition of the spoil. Once a year several *tāndās* unite in a "regional hunt"; otherwise inter-*tāndā* relations are limited to wedding festivities and adjudication on infractions of tribal law.

The clan system, as usual, regulates matrimony. Mr. Roy names thirty-seven clans, and the list is not exhaustive. Most of the clan names are "totemistic," but some connote localities and some clans bear the names of alien castes and tribes, which indicate some infusion of alien blood. Each clan has its peculiar traditions, observances, and cults, and several clans are admittedly of hybrid origin. Broken folk cannot afford to be exclusive.

Lads and lasses are schooled by the familiar "dormitory" discipline of primitive culture. The dormitories are not exactly shrines of purity—boys will be boys,—but schoolboy etiquette insists that a lad should stick to his own sweetheart and not poach. With marriage comes respectability. Of marriage there are ten forms, nine of them informal and gallant, the tenth only is "regular," heavily laden with the elaborate negotiation and formalism in which India delights.

Mr. Roy's appraisal of Birhor religion is kindly and sound. He rightly discriminates between "personal" gods and spirits propitiated with prayers and sacrifices, and impersonal "powers, forces, or energies" controlled by spell or threat or other "magical" device. Religion to the Birhor is not all gloom and terror. Singbōngā, the supreme being, is benign enough, but, like other superior personalities, somewhat aloof. Then there are hosts of clan spirits, *tāndā*-spirits, family spirits (mostly ancestral), tutelary spirits, etc., whose censorship of moral lapses must exercise a salutary influence on social life. Mr. Roy's outline is clear and concise, and he neatly sums up the *summum bonum* of Birhor existence: "the power to control and direct the *impersonal* energies and powers and the stray *personal* powers—and secure the goodwill of the more important *personalised* powers or spirits."

In Birhor belief a man has two souls, one male, one female. When he dreams, the male soul quits the body, the female soul remains in charge, and the body

sleeps. But if the male soul lingers, its mate goes out to search for it, and the body dies; temporarily, perhaps, for the spirit-doctor (*māti*) is requisitioned and does what he can to call back the truant souls and restore life.

The Birhors are by no means untouched by Hindu influences, markedly so in the few religious festivals celebrated by certain clans, and in folk-tales of which Mr. Roy gives numerous examples. The Birhor version of the Rāmāyana is of special interest.

Students of Indian anthropology are deeply indebted to Mr. Roy for the light he has thrown on the past and present culture of the Chota Nagpur plateau. In the Bihar and Orissa Research Society's Journal he has opened up new ground in the archæology of his area. His monographs on the Mundas and Oraons are classics. "The Birhors" is yet another first-rate study, a study not merely of an obscure tribe but also of the workings of that mysterious complex of thought and feeling which go to make up human culture. The volume is handy in size and easily read, in spite of the numerous misprints inseparable from Indian typography. The plates are well chosen, but not too well printed. Mr. Roy is never a theoriser or a partisan; his ciction is simple and precise, his inspiration comes straight from the hearts of the humble folk he has made his friends.

F. J. RICHARDS.

Research at High Temperatures.

Fours électriques et chimie. Publié sous la direction de Prof. P. Lebeau, avec la collaboration de C. Bedel, Prof. A. Damiens, P. Fleury, Prof. P. Jolibois, Dr. M. Picon, Prof. G. Ribaud, Dr. H. Weiss. (Fondation Edmond de Rothschild pour le développement de la recherche scientifique.) Pp. xii + 585. (Paris: Les Presses universitaires de France, 1924.) n.p.

THE Committee of the Fondation Edmond de Rothschild has caused this book to be written as a preliminary step in the planning of investigations with electric furnaces, to extend scientific knowledge and industrial applications. It forms a review of electric furnace constructions and their applications and succeeds in covering the ground fairly thoroughly. Recognising that advances in chemistry and physics are frequently closely associated with the invention or development of new apparatus, an attempt is made to describe various types of electric furnace and to associate with the several forms a summary of the main researches already carried out by their aid.

Such a compilation has both its advantages and its dangers. Bibliographical surveys, or *documentation* as the French so aptly describe them, undoubtedly save

the investigator a lot of tedious work; and literary searching is not only wasteful of the time, but actually detrimental to the originality of the more able scientific worker.

On the other hand, there is a real risk that too much attention will be paid to the acquisition of replicas of the apparatus of the earlier workers, without due regard to the more important part which the inspiration and skill of these investigators played in its design and use. The history of the scientific application of electric furnaces itself provides an excellent example of the power of the able experimenter to override all limitations in apparatus and equipment. The late Henri Moissan is even to-day unsurpassed in the richness of his discoveries in this field, and yet he had, for almost the whole period during which he was engaged in these researches, only the most simple equipment, and the only supply of electric current in his laboratory was that which he could provide from primary batteries, the electric furnace work being carefully prepared beforehand but executed on occasional pilgrimages to a central supply station, several miles away from the laboratory.

Whereas the work of Moissan was concerned chiefly with the primary survey of the subject and the production of metals and new compounds, hitherto outside the practical scope of ordinary methods of heating, later applications have called for apparatus of greater precision. The need for close control of the working temperatures, as in the determination of such physical constants as the boiling points of the metals, for heating *in vacuo* to prevent the oxidation or the carburisation of metals; or for high pressure to attain measurable yields of some of the products of high temperature chemical reactions, has in each case led to the design of much more complicated apparatus. The description of this apparatus is fully dealt with in this book in seven chapters devoted respectively to electric furnaces of the following types: (1) metallic resistance, (2) carbon resistance, (3) vacuum, (4) high pressure, (5) induction and high frequency, (6) arc, (7) spark and gas discharge; whilst an eighth chapter summarises the methods of pyrometry.

With a subject that covers such a wide borderland of physics, chemistry, and electrical engineering, it is not surprising for a reviewer to be able to find a few omissions—such as all mention of the electric furnace production of silica glass—but the survey on the whole is remarkably complete and superior to what is generally provided by French scientific books; and it can be strongly recommended to English workers who have need of a reference book on the subject. The Fondation Edmond de Rothschild (see NATURE, 1921, vol. 107, p. 563) is one of the largest French endowments for

physico-chemical research, and the further development of this branch of its activities, which will apparently consist in supporting work to supplement existing knowledge in this field, will be awaited with much interest.

R. S. H.

Lakes.

Les lacs, leur mode de formation, leurs eaux, leur destin : éléments d'hydro-géologie. Par Léon W. Collet. Pp. xii + 320 + 28 planches (Paris : Gaston Doin, 1925.) 35 francs.

THE limnologist is fortunate in having at his disposal two such excellent works of recent date as Prof. Halbfass's "Grundzüge einer vergleichenden Seenkunde" and Prof. Collet's "Les lacs." Though the subject is the same, there is room for both. The mode of treatment is very different and there is little overlapping between the two. Prof. Halbfass's book is the more general. Prof. Collet's deals chiefly, though by no means solely, with the lakes of Switzerland and the Alps, and some of these it describes in considerable detail. Prof. Collet was formerly Director of the Swiss Hydrographical Service, and the accounts that he gives of the observations made by himself or under his direction form a valuable feature of his book. He also took part in Sir John Murray's survey of the Scottish lochs.

Prof. Collet's book is divided into three sections: the formation of lake-basins, the water of lakes, and the destiny of lakes. Under the last heading he includes not only the filling of lakes by deposition but also the utilisation of their waters. The first section occupies about a hundred pages. Owing to the somewhat sceptical attitude adopted by some writers in England, the English geologist will probably be most interested in the lakes attributed to glacial erosion and to solution. Prof. Collet himself has no doubt about the erosive powers of glaciers, and like Penck and Brückner believes that most of the lakes of the Alpine borders are due to overdeepening where the glaciers debouched upon the plains. Lake Geneva, however, has had a more complex history, which has not yet been fully worked out; and only the upper basin is due to this cause. In connexion with this question of overdeepening he gives an interesting photograph of the left bank of Lake Ritom. It shows glacial striations rising steeply from the water, the direction of the rise being towards the outlet. It proves, he thinks, and it certainly suggests, that the glacier itself rose towards the barrier at the lower end of the lake. Perhaps, however, even this will not convince the confirmed sceptic, for it is still possible that the greater part of the ice in the lake-hollow may have been stagnant and only the upper layers moving.

No geologist denies the efficiency of water as a solvent agent; and in Cheshire, depressions of the surface due to the solution, natural or artificial, of the salt beneath, are too common to leave any doubt as to their cause. But it is not so clear in England that any lake-basins have been formed by direct solution of the rock that occupied the hollow. Hollows have been produced in this way in our limestone districts, but they do not usually hold water, for there is generally an underground escape. In the Karst, however, and in the Limestone Alps, the conditions are more favourable, and Prof. Collet describes several examples. In some there is no visible outlet, in others a part of the water escapes superficially and a part underground. By means of experiments with fluorescin, Prof. Collet has shown that in several cases the subterranean outflow is not in the direction that the surface topography would lead us to expect.

The section on the water of lakes occupies 85 pages and deals with the influence of the regime of the affluents, the temperature, the chemical composition, and the colour. One of the most interesting parts of this section is the account of Lake Ritom. For stable equilibrium the water must increase in density downwards. Consequently in temperate regions, when there is no disturbance due to wind or other causes, the temperature of the water in summer decreases downwards; in winter, if the surface water is below 4° C, the temperature increases downwards. Lake Ritom sometimes shows a layer of cold water lying between warmer water above and below. The condition is due to differences of salinity. The upper twelve and a half metres—the measurements were made before the level of the lake was artificially altered—consists of oxygenated water with a low percentage of salts. From thirteen metres downwards the water is highly saline and contains sulphuretted hydrogen. There is a transition layer of about half a metre in thickness. The lower water is almost stagnant and has a temperature of about 6° C., varying little with the depth or with the season. The fresher water is never so cold as to become heavier than the salt water beneath, and consequently the convection currents in the former do not extend into the latter. The upper layer, in fact, behaves as if the salt water formed the floor of the lake and the temperature at this false floor is often less than 6° C.

The salts in the lower water are derived from the dolomitic and gypsum-bearing Triassic rocks of the region, not by direct solution of the walls of the hollow but from underground sources. Since the water is nearly stagnant the supply is doubtless very slow—it must, in fact, be so slow that it is balanced by diffusion into the upper layer. This upper layer consists of the

water from the visible affluents of the lake, which are all only slightly mineralised, and the fresher water flows over the saline layer and escapes by the river Foos.

The third section, consisting of rather more than a hundred and twenty pages, is the most important from the practical point of view, and should be consulted by engineers who have to do with the construction of reservoirs for any purpose. All lakes tend to be filled up in time by the deposits brought into them by streams and rivers, and the same is true of reservoirs. In a country like Switzerland the process is often much more rapid than in England. The original artificial lake of Perolles was filled in fourteen years, and the rate of deposition in other cases is equally high. This is one of the matters investigated by the Hydrographic Survey, and though the rate must vary greatly in different cases, the figures which Prof. Collet gives are of great value. They are, in fact, almost the only figures available which are more than guesses.

Sufficient has been said to show the interest of the volume. Prof. Collet writes very clearly and the book is admirably produced and illustrated. There are 63 maps and diagrams and 28 plates of photographs. Apparently the paper on which the text is printed is heavily loaded, for though the book is not bulky it is inconveniently heavy. This is the only fault that can be found with it.

P. L.

Our Bookshelf.

The Social and Political Systems of Central Polynesia.

By Robert W. Williamson. Vol. 1. Pp. xxix + 438 + 6 maps. Vol. 2. Pp. v + 496. Vol. 3. Pp. v + 487. (Cambridge: At the University Press, 1924.) 75s. net.

THE amount of labour involved in the writing of this book has been, literally, enormous. The bibliography of books covers eleven closely printed pages, and to these must be added innumerable articles in the scientific journals of which the titles alone occupy nearly a page. Yet the Sandwich Islands and New Zealand are not included, and except for an opening chapter on origin and migrations, no subject outside what is strictly social or political is discussed. Even such matters as the functions of the chiefs in relation to ritual observances are postponed, with other topics connected with religious ceremonies and customs, for future consideration in another work.

Within the limits that Mr. Williamson has set himself, his treatment has been thorough. The difficulties arising out of the often unsatisfactory, and sometimes contradictory, character of the evidence—evidence collected at widely separated periods of time, by individuals of very different powers of observation and of varying capacity for precision of statement—have been squarely faced and usually resolved into a coherent account. Mr. Williamson's examination of local and social grouping may be taken as a very fair sample both of the difficulties and of the results of his meticulously careful method of analysis. Limitations of space forbid

any critical examination of conclusions which are based upon a mass of detail drawn from so extensive a field; but it may be mentioned that Mr. Williamson finds that the fundamental factor in the social and political system of Polynesia was the recognition of the office of the head of the group, taking this term as applicable to functions ranging from those of the chief of the most extensive area under one authority to the head of a family group. Mr. Williamson is to be congratulated on the successful accomplishment of a heavy task by which he has earned the gratitude of all students of ethnology.

Automotive Electricity: a Text and Reference Work on the Construction, Operation, Characteristics and Maintenance of Automotive Ignition, Starting, Lighting and Storage Battery Equipment By Earl L. Consoliver. Pp. xv + 665. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925) 20s. net.

ELECTRICITY plays a most important part in the equipment of a modern motor-car. In addition to igniting the fuel charges within the engine cylinders, it starts the engine and illuminates the road for night driving. It also operates the horn and other signal devices, and in many cases it operates electric gear shifts, hand-warmers, cigar-lighters, and carburettor heating devices. It plays an equally important part in connexion with motor-boats and aeroplanes. There is a demand, therefore, for a book which will give a clear and trustworthy account of the ignition requirements, the starting and generating equipment, and the management of storage batteries.

The volume under notice, whilst disclaiming to be an encyclopædia, does touch pretty thoroughly on all these subjects. Naturally American practice is most fully considered, but most of the advice given is directly applicable to all makes of car. The title led us to expect that vehicles driven exclusively by batteries would be described and that their limitations would be considered. This branch of the subject, although an important one—more especially in the United States—is not considered. Many useful hints can be picked up from this book. The author has had considerable experience in instructing those who have to look after motor-cars; he gives the minimum of theory and lays stress on those points which are important in practical running.

Practical Advice to Inventors and Patentees: Inventions and How to Patent Them. By C. M. Linley. Pp. vi + 126. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 3s. 6d. net.

THIS thoroughly practical little book can be strongly recommended to inventors who wish to know how to exploit their ingenuity commercially, for its author appears to have learned the ropes in the hard school of experience. The principles of patent law and practice are set forth clearly in non-technical language and the exposition of these is sound, although the following points might be noted for future editions: a British patent cannot be invalidated by publication in a prior British specification more than fifty years old (pp. 47, 48), while it can be invalidated by publication in a foreign specification taken by the Patent Office library, whether or not there has been additional publication

in a periodical (p. 45); and p. 44 would be improved by the addition of a paragraph on the gentle art of phrasing disclaimers.

It is, however, when he comes to more practical topics that the author is at his best: he shows a keen insight into human nature and much ripe wisdom when he explains how to attract a capitalist, how to deal with infringers, how to combine discipline with fair play when inferior workmen become inventive, and how to perform a good many other difficult but profitable feats which are not mentioned in text-books of patent law. His anecdotes relating to the history of inventions also make good reading. The book is written in a conversational style and is all the more readable on that account, but it would be the better for a thorough revision of its syntax, which is in places slipshod.

Methods in Plant Histology. By Prof. Charles J. Chamberlain. Fourth revised edition. Pp. xi+349. (Chicago: University of Chicago Press; London: Cambridge University Press, 1924) 3 25 dollars.

SINCE the first edition of this book appeared in 1901 it has become a well-known manual of laboratory methods. Its usefulness may be judged from the succession of editions of continually increasing size. The present edition is largely re-written—a task necessitated in part by the stimulus to improvement in technique resulting from previous editions. There are additional hints on details of method throughout the book, and these are especially valuable in the field of cytological technique, where success—like genius—depends upon an infinite capacity for taking pains.

The Venetian turpentine method for mounting algæ has been made more specific and could doubtless be more widely used with advantage, as the staining results are brilliant when good preparations are obtained. A short chapter is added on the cellulose acetate method of softening woods for sectioning—a method developed by Dr. Kernot and Mrs. Williamson, which softens the hardest woods without destroying details of structure.

The standardisation of American stains, on which a scientific commission has been at work since the War, has led to a great improvement in dyes, which now often surpass the old Grüber stains, and incidentally has led to alterations in the directions for staining given in this book. Among the micro-chemical tests we are surprised to find no mention of aniline hydrochloride, which is such a useful laboratory reagent for lignified tissues.

R. R. G.

An Outline of Automatic Telephony. By William Aitken. Pp. 143. (London: Ernest Benn, Ltd., 1925.) 5s. net.

SINCE the introduction of automatic working, telephony is becoming more and more a highly specialised science. To the outsider the problem appears to be one of the greatest complexity. Any telephone in an area has to be connected in a few seconds with any other telephone in that area so that two persons can converse clearly and uninterruptedly for a given period. As a mistake in dialling is always possible, the caller must be able to break down the connexion at any instant. The cables between any two switching stages may be in use or faults may develop in them. Signals therefore have to be given to the caller to indicate abnormal conditions.

Further, supervisory signals have to be sent to the attendants and the sensitive pieces of apparatus have to be protected by suitable devices. Service has sometimes to be free, but generally it is either metered or obtained by "coin in the slot." As all these variations have to be done automatically and with the minimum risk of error, the difficulties that arise are unending, and telephone engineers are to be congratulated on having developed working systems. Mr. Aitken gives a good technical description of the various types of systems in use, particular stress being laid on the Strowger Director System, which is the one being installed in London. The system he adopts of describing the "circuits" is original and easily intelligible.

Sulphuric Acid Concentration. By P. Parrish and F. C. Snelling. (Chemical Engineering Library, Second Series.) Vol. 1: By Hot Gases. Pp. 141. Vol. 2: In Heated Vessels. Pp. 147. (London: Ernest Benn, Ltd., 1924.) 6s net each.

THE chief merit of these two small volumes is that they are written by practical men who possess a ripe and successful experience of sulphuric acid manufacture. For this reason they will be read and studied with profit by the works' chemist and engineer, whilst the fact that they contain a considerable amount of information which is not found in ordinary text-books will make them appeal to the teacher and student in technical institutions. From the educational point of view, however, they have one drawback, namely, defective composition: there is scarcely a statement in them which could not be put into clearer and terser English; but even this could be turned to good purpose by a capable teacher.

The accounts of the Kessler and Gaillard methods of concentration in the first volume, and of cascade systems in the second, are particularly useful, and, like the rest of the subject-matter, quite up-to-date from the point of view of British practice. Two chapters are devoted to constructional materials, and one to transport and storage. In the final chapter on possible developments, the view is expressed that in the future "chamber" acid (70-80 per cent.) and oleum will be produced simultaneously in one plant, and rectified acid (96-98 per cent.) will be obtained by mixing them on the spot.

The Wandering Scholar. By David G. Hogarth. Pp. v+274. (London: Oxford University Press, 1925.) 8s. 6d. net.

THIS book is neither a reissue nor a new edition, but in part is both. It is a combination of two books, "The Wandering Scholar" and "The Accidents of an Antiquary's Life," one published in 1896 and the other in 1910. Of the first, two chapters and some paragraphs are omitted; of the second, the introductory chapter. The account of the Anatolian Turk under the old Hamedian regime, a piece of description and psychological analysis of remarkable penetration and insight, is retained. Those, if any, who are unacquainted with these delightful sketches of travel and archæological exploration in Asia Minor, Greece, and Egypt, with their humour and their sympathetic appreciation of the people of each country, will be grateful for their reissue in the convenient form of a single volume.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Isotopic Composition and the Atomic Weight of Chlorine in Meteorites.

THE most accurate determinations of the atomic weight of chlorine indicate that on earth this element consists of 76 6₅ per cent. of chlorine of isotopic number 1 (atomic weight = 35) and of 23 3₅ per cent. of isotopic number 3 (atomic weight = 37). It is of interest to determine the composition of this element in meteorites, and this has been done by the present writers, with the result that meteoritic chlorine has been found to have exactly the above isotopic composition. Within the limits of error of extremely accurate work, the atomic weight of meteoritic chlorine is found to be the same as that of this element as found on earth.

Presumably the material of meteorites has not been mixed with that on earth within the last few billion years. Thus, if during this period there has been any disintegration or formation of atoms of chlorine, it has either (1) not affected at all the relative amounts of the two isotopes, or (2) the relative amounts have been affected to exactly the same extent in both locations. The additional possibility that the coincidence is accidental seems to be ruled out by the similar results of Baxter for the atomic weight of meteoritic nickel. Have the materials involved ever been mixed with sufficient thoroughness to explain these results? According to Harkins (J. Am. Chem. Soc., 39, 856 (1917); *Phil. Mag.*, 42, 332 (1921)) the atoms of the lighter isotope are more stable, and a large part, if not all, of the exhibited constancy of isotopic composition of elements is due to the net effect of the different types of atomic stability.

The average of the best results for the atomic weight of terrestrial chlorine is 35.467. The five results obtained by us on highly purified meteoritic chlorine are 35.466, 35.468, 35.469, 35.469, 35.465, with an average of 35.4674. The method used for the determination of the atomic weight consisted in weighing about two grams of extremely pure silver in a quartz flask, dissolving in nitric acid, and in finally adding hydrogen chloride obtained from a meteorite in sufficient excess to convert the silver completely to silver chloride. The water and acids were evaporated and the silver chloride fused, the last fusion being carried out in an atmosphere of chlorine. The balance used gave a deflexion of half a millimetre on the scale for a hundredth of a milligram. The methods used throughout were similar to those used by Richards and his associates, with the exception that the smaller amount of material available made it essential to use a balance of the highest sensitivity compatible with the requisite stability and constancy.

Chlorine from wernerite, from apatite, and from purified commercial hydrochloric acid gave results which were identical with those on the meteorite, within the limits of error of the work.

In calculating the percentages of the isotopes as given in the first paragraph, use was made of the Whole Number Rule of Harkins and Wilson (J. Am. Chem. Soc., 37, 1367-1421 (1915)) and the assumption was made that the atomic weights of the separate isotopes are exactly whole numbers. While any

deviations from these whole numbers affect the percentages given, it is obvious that they do not affect the identity of composition of meteoritic and terrestrial chlorine as exhibited by the identity in the atomic weights of the mixtures from the two sources.

WILLIAM D. HARKINS,
S. B. STONE

University of Chicago,
August 11.

Coastal Errors in Radio Direction-Finding.

FOR many years now it has been the experience of those dealing with wireless direction-finders that when the path of the waves being received lies approximately parallel to the coast, an error in apparent bearing is obtained which may or may not be constant. It is probably correct to state that the error is always such as to indicate that the waves in crossing from sea to land experience a deviation in a direction towards the normal to the coast-line at a point of transit. This is consistent with the generally accepted assumption that the velocity of waves over sea-water is greater than the velocity over land, due to the lower conductivity of the latter. The magnitude of the possible error which may occur appears to be usually of the order of 3° to 5°, although greater errors up to about 10° are apparently sometimes experienced.

While a fixed transmitting station should, in the absence of night variations, give a constant bearing even including any coastal refraction effects, a little consideration of the case will show that several stations at different distances on the same great circle from the D.F. stations will give different errors. It is thus evidently impracticable to apply a correction to the observed bearing of a ship at a D.F. station without assuming a knowledge of its true bearing and distance, and it is becoming the practice of those in charge of shore D.F. stations to supply information as to the arcs over which the bearings supplied may be considered to be reliable.

In the experimental direction-finding work conducted by me during the last four years, errors have been measured in certain cases which appear to support the above experience. At one D.F. station situated on the east coast of England, the only cases in which consistent errors of more than 1.3° were obtained in daylight, were found to be those for which the direction of transmission was within 20° of the coast-line. On the wave-lengths of 450 and 600 metres employed in the majority of these particular observations, this coastal error was of the order of 3° to 4.3° for some of the transmissions. In one instance, in which the wave-length was systematically increased from 500 to 2600 metres, the corresponding error decreased from 3.2° to 1.4°. On higher wave-lengths the possible coastal error observed in this and all other cases was less than 1°. In every instance the error was such as to indicate a bending of the waves towards the normal to the coast-line, in passing from the sea to the land side of the boundary.

From Zenneck's analysis (J. A. Zenneck, *Ann. der Phys.*, 1907, vol. 23, pp. 846-866) of the case of a plane wave travelling over the plane boundary of a semi-conducting ground and non-conducting air, it can be shown that the velocity of wireless waves in a horizontal direction is greater over land than over sea. Hence the effective refractive index, which is the ratio $\frac{\text{velocity over sea}}{\text{velocity over land}}$, is less than unity, and a wave will be bent away from the normal in crossing

a coast-line from sea to land. Eckersley (T. L. Eckersley, *Radio Review*, 1920, vol. 1, pp. 421-428) has previously made a study of the refractive effects for wireless waves crossing the Egyptian coast from the Mediterranean Sea, and obtained experimentally a refractive index of 1.02 for a wave-length of 1000 metres. A theoretical value of 1.067 was given as being applicable to this case, but in view of the above remarks a mistake would appear to have entered into the derivation of this value.

It has been shown from recent measurements (R. L. Smith-Rose and R. H. Barfield, *Proc. Roy. Soc.*, 1925, vol. 107, pp. 587-601) that the effective conductivity of the ground in the south of England at wireless frequencies is approximately 10^8 e.s.u. If this value be used to calculate the refractive index for the English coast, taking the wave-length of 450 metres, the value of μ obtained is 0.999991. This means that the ratio of the velocities of these waves over the sea and land differs from unity by less than 10^{-5} , and it is thus difficult to account for the deviations which have actually been observed, quite apart from the fact that they are in the wrong sense. It must be remembered, however, that in such a case the deviation $\delta\phi$ of a wave crossing the boundary at an angle of incidence θ can be shown to be

$$\delta\phi = \frac{\mu - 1}{\mu} \tan \theta.$$

Hence, although $\mu - 1$ is only 10^{-5} for the case considered above, $\tan \theta$ tends to become infinite as θ approaches 90° . So that in the case of waves which pass along the coast at practically grazing incidence for a distance of several miles, the error may reach a value of two or three degrees as actually observed. Two difficulties in making a strict comparison with experimental results are that the coast-line is not usually straight for any appreciable distance, and that it is doubtful in many cases if the effective boundary between the sea and land is defined by the high-water mark used on charts. For these reasons the angle of incidence of the waves on the coast-line is a rather uncertain quantity. The problem is further complicated by the fact that the boundary is

measured. Since the land D.F. stations are often situated within a wave-length of the boundary, it is important to know exactly what is happening at such a short distance. Providing the change from one medium to another at the boundary is reasonably sudden, there appears to be no reason for supposing that the deviations of waves crossing it is not equally

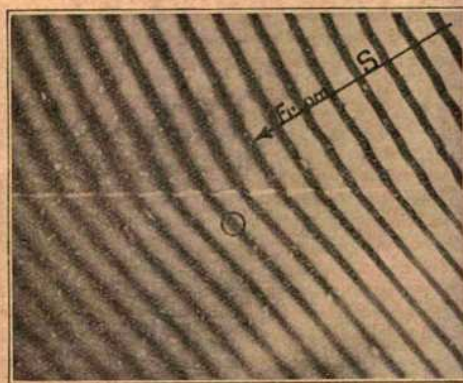


FIG. 2.—Ripple photograph. Source S and observing station O on opposite sides of boundary. The wave front observed at O is not at right angles to the true bearing of S.

sudden. This point has been very nicely demonstrated by the analogous case of water ripples in which the change in velocity is produced by an alteration in the depth of the water in the ripple tank. The photograph reproduced in Fig. 2 shows that the change in direction is quite sudden and is complete within a fraction of a wave-length. Should the change in conditions from one medium to another be gradual, the resulting refraction should be gradual, and at the limit should be continuous.

Sex-determination in *Trialeurodes vaporariorum*.

THE common Greenhouse White Fly (*Trialeurodes vaporariorum*) presents a rather curious case of sex-determination. Originally (1903) Morrill in America discovered that it was parthenogenetic and that all unfertilised eggs developed into males; this finding was corroborated later on by Stoll and Shull (1919). Hargreaves (1914) and Williams (1917), investigating the same species in England, found, however, that in this country unfertilised eggs laid by virgin females exclusively gave rise to females. Random collections in America had shown a considerable proportion of males (40-50 per cent.), while in England, none or a few males were found; only one small colony found by Williams at Merton agreed with the American strain with regard to its sex-proportion.

These investigations indicate that *Trialeurodes vaporariorum* has two races, an "American," showing arrhenotokous parthenogenesis, and an "English" with thelytokous parthenogenesis, a most interesting fact, which, however, does not seem to be completely unique in the animal kingdom (cf. *Trichogramma pretiosa*, a Chalcid, Howard and Fiske, 1911). As to the progeny of mated females, Williams in the exceptional Merton colony had obtained both sexes after pairing of the mother individual, and therefore thought himself justified in concluding that fertilised eggs may give rise to both males and females. Stoll and Shull with individuals of the "American" race arrived at the same experimental result, but maintained that the interpretation might be the same as in the honey-bee, where the queen after mating can lay both fertilised and unfertilised eggs, developing into females and males respectively. Furthermore, it seemed probable that this is really the case, for they obtained in some experiments a great majority of females after mating, while if Williams's interpretation is correct, no more than 50 per cent. of the progeny could have been published.

generations. Attempts at crossing females of the "English" race with males of the "American" gave in all experiments together: in F_1 , 766 females + 1 male; in F_2 (parthenogenetic progeny of F_1), 999 females and 4 males. (Probably the males, which only appeared in 2 lines of 11, have originated from slight contamination of the initial material with "American" females.) Then even after the "crossing" the female-producing strain persists, i.e. probably no effective crossing has taken place. It is very likely, though hitherto not proved, that the rare males in the thelytokous strain do not differ genetically from the males of the arrhenotokous race. Therefore, instead of speaking about two races, one might just as well say that *T. vaporariorum* has two kinds of females: obligatorily parthenogenetic thelytokous and facultatively parthenogenetic arrhenotokous together with haploid males.

The cytological examination of the thelytokous females shows that the oogenesis up to a certain point goes on in just the same way as in the arrhenotokous ones. The chromosome number is the same; the usual leptotene and pachytene stages are met with in the prophase; a pseudo-reduction takes place, thus only 11 chromosomes are seen during the maturation divisions; two polar nuclei are produced: in short, the egg behaves just as if it was preparing for fertilisation or development with the haploid chromosome number. But afterwards the 11 chromosomes divide, and in all segmentation nuclei and later on in the larval mitoses 22 chromosomes always are found. So close a resemblance in the behaviour of the chromosomes within the same species between obligatorily parthenogenetic eggs and eggs that can be fertilised has been found in scarcely any other animal.

For further particulars and discussion I must refer to my detailed paper which will probably be published in the course of the winter. In the same paper will appear an examination of the cytology of *Aleurodes proletella*, in which species I have been able to prove that really only one maturation division takes place in the oogenesis of the haploid males, while in the thelytokous females the parthenogenesis

University since the second half of the 16th century this passed through a period of great splendour in the early 19th century, shortly after the partitions of Poland, and it has been revived now; Leopold (which the Germans call Lemberg, and the Poles Lwow) celebrated its 250th anniversary as a Polish university in 1912.

Volume 5 of *Nauka Polska* being devoted especially to the movement called *regionalism*, prominence has been given in it (and accordingly, in the notice in NATURE) to local scientific societies in smaller provincial towns; but the fact must not pass unmentioned that learned societies for the promotion of research existed and flourished through all the vicissitudes of foreign rule in the 19th and early 20th century in such important centres of Polish life as Cracow, Warsaw, Poznan (Posen), Lwow (Lemberg), and Wilno.

Readers of NATURE before the War must have been familiar with the names of such Polish scientific workers as Smoluchowski in the field of physical science, Natanson in natural philosophy, Cybulski in physiology, Marchlewski in chemistry, Zarembka in mathematics, Nussbaum-Hilarowicz in biology—to mention only a few. Some of these men continue their work in the new Poland after the War. Others—like the lamented Smoluchowski—have since been taken from us, but new men are stepping into the breach, year in year out, from among the 40,000 university students of the new Poland. It is surely a proof of zeal for scientific research under the great difficulties which all countries experience after the War, and of which devastated Poland has more than her share, that of about 100 papers read at the International Geographical Congress in Cairo in 1925, no fewer than 22 were by Polish authors.

The writer of the notice in NATURE refers to the handicaps created by "restricted finance", but it is a source of pride and gratification to every Polish scholar and scientist that restrictions in the Polish budget have been exercised mainly in departments other than that of education and the endowment of research: this section of Polish State expenditure, in fact, has never ceased to increase in proportion to the rest since Poland has come into renewed existence, and it represents upward of one-sixth of the total expenditure of the State in the current administrative year. With State assistance on a large scale supplementing the private efforts in the way of the organisation of research in Poland, many new institutions have arisen since the War, such as the Geological Institute in Warsaw, which has done very useful service to the nation and to science in mapping out the mineral resources of Poland.

May I mention, finally, that Polish research bodies, like the Academy of Sciences at Cracow, regularly publish abstracts of the research work of their members in the shape of French, English, and German bulletins, and that English, in particular, has always figured rather prominently in the publications of the natural science section of the Academy.

R. DYBOSKI.

Royat, Puy-de-Dôme, France,
August 23.

Electric Discharge in Gases at Low Pressure.

A PAPER by Mr. McCurdy in the *Phil. Mag.* for November 1924 has recently come to my notice, and I shall be glad if space can be afforded me to correct certain statements made in it regarding the results of my work. I have also read with great interest the joint paper by Messrs. Compton, Turner and McCurdy in the *Phys. Rev.* for December 1924, and wish to

make a few comments on the subject now, leaving a further discussion of the result of my work on the nature of electric discharge through gases at low pressure for the Indian Science Congress to be held in January next.

Mr. McCurdy's information that my experiments under Sir J. J. Thomson pointed to the conclusion that striations cannot be obtained in pure nitrogen is, I regret to say, not correct. Not only did I get striations in pure nitrogen, but even in carefully purified helium—the purity of the helium being unquestionable—striations could be obtained. In argon, the absolute purity of which was not very carefully tested, remark-



FIG. 1.

able striations could be obtained. The accompanying diagram (Fig. 1) illustrates three argon striations, each consisting of two entirely detached parts, one the pink spherical glow showing the red spectrum of argon, and the other the bluish-green convexo-concave glow showing the blue argon spectrum. These two glows, however, appear connected to each other at higher pressures by a faint glow.

In fact, after having worked with pure hydrogen, helium, neon, argon, nitrogen, oxygen, chlorine, iodine, I came to the conclusion that striation can be produced in all pure gases, though the ranges of pressure and current density in the discharge tube suitable for the production of striation vary widely for different gases. I must confess that I did not try the effect of discharge in pure mercury vapour, but indirectly, by introducing traces of mercury vapour in pure unstriated helium discharge, I did get beautiful and well-defined mercury striations which began to appear one after the other from the cathode end of the positive column with increasing amounts of mercury vapour.

A careful study of the discharge in pure helium under different conditions and with the help of the rotating mirror points to the conclusion that the phenomenon of discharge is essentially intermittent, and that the conditions at the cathode and anode are of the same kind but of different intensity. It means that the positive ions and electrons or negative ions are ejected from the electrodes in regular pulses and move in opposite directions with different velocities. On this view the space charge or concentration gradient, as stated by Prof. Compton and others in their paper, can be easily understood.

The experiments cited to confirm the theory that a reduction in the concentration of the excited atoms helps the formation of striations do not appear to be conclusive. For example, the selective reduction of W_2O_3 can also be easily explained by the fact that the concentration of ions and electrons in the luminous region is greater than in the darker regions, and that, due to the consequent effect of more frequent elastic collisions and to the existence of potential gradient between the axis of the discharge tube and the glass walls, more dissociated hydrogen ions reach the glass wall in the region of the striations than of the dark spaces. Then again, even granting that the suggestion of striations noticed with increasing quantities of helium contamination in mercury was due to impurities and not a real effect, the conclusion drawn from the effect produced by helium, which is an inert monatomic gas of high ionisation potential, is inconclusive unless a comparative study of the effects of the addition of an electronegative gas and of pure nitrogen in similar circumstances is made.

I believe, however, that a decrease in the concentration of the excited atoms and in the mobility of the negative carriers—both effects very likely produced by the presence of negative ions—help to bring out well-defined striations, especially when the electro-negative and the electropositive ions have strong chemical affinity for each other.

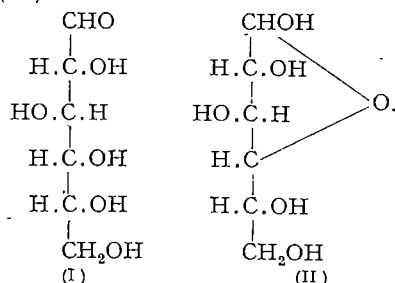
I shall now endeavour to publish the account of my work, as I have finally given up all hopes of getting suitable opportunity to perform further experiments on the subject done in the Cavendish laboratory between 1920 and 1922.

B. N. BANERJI.

Meteorological Office, Simla,
India,
August 5.

A Revision of the Structural Formula of Glucose.

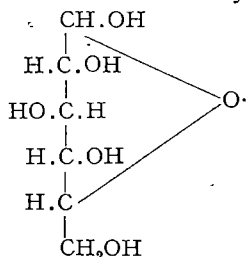
HITHERTO the balance of evidence as to the glucose structure has favoured the adoption of a γ -oxide ring formula (II.) which it is now customary to describe as a butylene- or 1:4-oxide structure. The property of mutarotation of sugars and the analogy which has been drawn between reducing sugars and their α - and β -methyl glucosides led to the abandonment of the older aldehyde formula (I.) for glucose in favour of (II.).



Whilst chemists have accepted the second of these formulæ as consistent with the experimental facts, yet it must be acknowledged that no direct proof of this structure has ever been advanced, and thus the allocation of a constitution to the commonest hexose rests mainly on the supposed analogy of the sugar with its related lactone, namely, gluconolactone.

In the aliphatic section of the Annual Reports of the Progress of Chemistry for 1924, published by the Chemical Society, the present writer expressed the opinion that current views regarding the formula of glucose would probably require revision. Meanwhile new evidence has been contributed by investigations conducted in these laboratories, and will shortly be published in detail, showing that normal tetramethyl glucose gives a δ -lactone on oxidation, whilst the corresponding γ -lactone is derived from the γ -sugar.

These results necessitate the adoption of the following constitutional formula for ordinary glucose:



In this formula the oxide ring shown in (II.) is displaced from the butylene-oxidic or 1:4 position, and

the attachment is that of a six-membered ring—that is, a 1:5 or amylenic oxide; and as this has been shown also to apply to galactose, mannose, xylose, and arabinose, the generalisation is reached that all aldoses exist normally as amylenic oxide forms. The γ -sugars of the aldehyde type must be regarded as butylene oxides.

Since glucose is an essential unit in most of the natural carbohydrates such as cane-sugar, maltose, lactose, starch, cellulose, it follows that the constitutional formulæ of these substances must undergo revision in the same sense.

W. N. HAWORTH.

Armstrong College
(University of Durham),
Newcastle-upon-Tyne, August 22.

Compton's Theory of X-ray Scattering.

READERS of NATURE may be interested in a short account of two experimental tests of Compton's theory of scattering which at present are being carried out here. Both of these tests deal with the total energy of the recoil electrons produced by hard X-rays.

One method is to compare the ionisation produced by the rays in very small (0.5 cc) air-ionisation chambers of different light substances (pure metals and salts). The ionisation in such small chambers is due solely to the secondary electrons from the walls. If these secondary electrons all had been of the photoelectric type, their number and therefore the ionisation would have been proportional to the third power of the effective atomic number of the wall substance. Thus, for example, the ionisation in a magnesium chamber should have been $8 \left[\left(\frac{12}{6} \right)^3 \right]$

times larger than the ionisation in a graphite chamber. Experiments show that for hard X-rays the ratio is considerably smaller, decreasing rapidly for decreasing wave-lengths. For the hardest X-rays which we have produced, the difference between the two chambers is only about 15 per cent. For the γ -rays there is no measurable difference. This decrease is due to the production of the recoil electrons, the energy of which is independent of the atomic number, and, as I have shown (Proc. Nat. Acad. Sci., 10, p. 441, 1924; *Zeit. für Phys.*, 29, p. 374, 1924), this energy can readily be determined by such measurements. For very hard X-rays ($\lambda < 0.15 \text{ Å.U.}$) our experiments verify Compton's theory to within experimental errors, which may amount to about 10 per cent.

In the second method, we measure the true absorption of hard X-rays in light substances like water. Under our experimental conditions, this true absorption is practically due solely to the production of the recoil electrons. The method consists in measuring the reflection of a very wide bundle of approximately parallel (and homogeneous) rays from the surface of a large mass of the substance, and measuring also the intensity of the rays at different depths under the surface. The difference between the incoming and the reflected energy must equal the energy absorbed in the substance, this amount being obtained by multiplying the average value of the intensity in the substance by the coefficient of true absorption. By introducing a correction for the photoelectric absorption, the absorption corresponding to the production of the recoil electrons is thus derived.

For water and very hard X-rays ($\lambda < 0.15$) we here also verify Compton's theory to within the experimental errors (about ± 10 per cent). (Compare *Phys. Rev.*, 25, p. 581, 1925.)

a marvellous event due to certain conditions which have never since been duplicated.

Similarly the primitive coelenterate, presumably a sponge, gave rise to ancestral Cnidaria still within the pre-Cambrian. Never since has the sponge given rise to anything but the sponge, but the phylum has continued to exist and to differentiate within seemingly fixed bounds. Before the close of the pre-Cambrian all the phyla of Invertebrata arose successively in this manner. Possibly we may include the vertebrates, although they have not yet been found so far back in time. These are well-known principles, but reiterated here because I think that they are not always given their true value.

I would emphasise—the origin of phyla as great events in geological history, the crowding of these events into the pre-Cambrian, the continuation of ancestral stocks, and their failure ever again to give rise to new phyla. It would appear, further, that higher phyla have not developed through highly specialised genera of lower phyla. For the invertebrates this is evident in the appearances of all the phyla in the pre-Cambrian; for the vertebrates, in the first place nothing is known with certainty, and in the second place the various phyla appeared long before high specialisation was attained by the ancestral stock. Amphibia arose from primitive Devonian ganoids, not from highly specialised teleosts; reptiles were derived from early Permian stegocephalians, not from highly specialised Anura or Urodela. The eutherian mammals appeared with startling suddenness in the basal Eocene, and before the close of the period had developed into all the great classes.

Evolution in the phyletic sense is not a gradual process, not uniformitarian, but marked by great events in time. Specialisation and consequent fixation of characters are adverse to phyletic differentiation.

It is apparent that phyla can arise only through genera and species. How far the phyletic principles may apply in the lower taxonomic ranks is an interesting question, the consideration of which would unduly extend this address. I would venture to state, however, that close adaptation (high specialisation) is likewise inimical to the production of new genera and species. Further, I believe that close adaptation is the main cause of extinction.

Let us assume the existence of an organism *perfectly* adapted to its environment. Is it not a safe conclusion that *any* change in environment must result in the death of such organism? That there is now or that there ever has been a perfectly adapted animal is extremely doubtful, but all animals must be more or less adapted or they could not exist. It may be stated that *the margin between perfect and necessary adaptation* is the zone in which organic evolution is possible; further, that the nearer an animal approaches perfect adaptation, the more liable it is to extinction on the advent of changed conditions. This conclusion is in accord with the generally recognised fact that in many instances highly specialised animals have suffered sudden extinction; it is also in accord with the general observation that the geological record is one of extinction and replacement in so far as species and even higher taxonomic divisions are concerned.

The great weight of geological evidence points to the

supplanting of one species by another, not to the transformation of species into their successors. A single transformation sequence may be regarded as sufficient to establish the principle, but an adequate explanation must be given of the failure of vertical seriations in the great majority of cases. This explanation is not yet forthcoming, and its lack stands as the chief item in the *contra* account of the balance sheet of evolution.

It is to the unfavourable changes that we must look for an explanation of the more deeply seated organic evolution, and by unfavourable I mean adverse to the present condition of the animal in that it is forced to further adaptation. A change of this kind is not of necessity *adverse to life*; it may even be stimulating. The animals towards the margins of a colony, by reason of their less perfect adaptation, may in a few instances survive an unfavourable change. The first impulse of these survivors will be to escape by flight, and thereby diminish the fatal suddenness of the change and thus achieve adaptation.

The new species would arise rather suddenly with but few individuals of the transition stages. Arrived at a favourable habitat, migration would cease, multiplication would ensue, and closer and closer adaptation would be achieved. Eventually an approximation to perfect adaptation would render the new species liable to extinction on the recurrence of unfavourable conditions.

This explanation of the common failure of vertical seriations emphasises migration as a factor in evolution and leads to the conclusion that transitional stages are few in number, scattered over wide geographical extents, and disposed in stratigraphically oblique lines. Barrell's "diastems," to be referred to later, support this explanation of abrupt changes in the faunas.

THE AGE OF THE EARTH.

The mysteries of time and of space have long been subjects of profound contemplation and scientific inquiry; they are intimately connected with the destiny of man and bring him into touch with the infinite. High is the cultural value of the mere contemplation of infinity, and of supreme importance is any light that may be thrown on a problem long regarded as beyond human comprehension. In recent years the theory of relativity has opened to the mathematically trained mind a possible avenue to a solution, but to most geologists this avenue is a closed road.

The determination of the actual age of the earth has long engaged the attention of philosophers and scientists, and various widely divergent estimates have been made by approaching the subject from different points of view.

Kelvin, Tait, King, and other great physicists but a few years ago allowed the geologist a maximum of 40,000,000 years for the age of the earth. Recent studies on radioactive minerals have induced the same school to raise the figure to 1,710,000,000 years, a *volte face* that emphasises the danger incurred by "the dictatorial hierarchy of exact scientists" in raising a mathematical structure on an insecure foundation.

The chief methods of determining the age of the earth other than those based on radioactivity, are: the rate of decline of solar energy, the gradient of earth temperature, the quantity of salt in the seas, the rate of organic

differentiation, and the rate of denudation of lands and of accumulation in the seas in relation to the known thickness of strata made throughout the geological ages.

The determination of age by means of radioactivity depends on the fact that uranium and thorium break down into lead and helium, and that the rate of this disintegration is known. The time required for half a given amount of these elements to break down is known as the half-value period. This period, according to Gleditsch, can be calculated to within 2 per cent.; for radium it is 1660 years and for uranium 6×10^9 years. An atom of uranium breaks down into one atom of lead and eight atoms of helium; if the content in these elements can be measured and compared with the quantity of unaltered uranium in an equal volume of the mineral, it is evident that the age of the mineral can be deduced.

Lyell long ago demanded 240,000,000 years for organic differentiation, and Darwin thought 200,000,000 too short for the purpose. On stratigraphic evidence, Barrell considered 250,000,000 a reasonable estimate for the duration of geological time since the pre-Cambrian.

The history of the subject shows that high figures were originally proposed by geologists and that, later, they tried to lower their estimates under the influence of the shorter time allowed by the physicists. More recently, the greater figures endorsed by the physicists permit the geologist ample time for his processes; both lines of inquiry are now pointing to the same result—higher and higher estimates of the immense antiquity of the globe.

Intimately connected with the estimation of time are the rates of erosion of old rocks and of deposition of new. Herein lies the most dependable geological means of determining the duration of the periods; nevertheless, there are serious difficulties to overcome, among which may be mentioned: variations in the rate of decay under different conditions, variation in the rate of deposition, and the occurrence of unrecorded intervals either evident or obscure.

The rate of erosion has received much attention, but as this factor is obviously dependent on the shape and condition of the land surface, its average for all time is difficult to estimate. Barrell considers that denudation by solution lowers the land surface one foot in 30,000 years, and that mechanical degradation accomplishes this result in 13,800 years. The two forces acting together require 9000 years to effect one foot of erosion.

Barrell's estimate of 250,000,000 years since the beginning of the Palæozoic was arrived at by a study of details of deposition under the hypothesis of rhythms in geological time. According to this author, time is to be measured by rhythms or pulsations, the greater rhythms having shorter rhythms imposed upon them. The longer are to be measured in terms of the smaller, and the smaller in terms of years. A single rhythm is an erosion cycle and small partial rhythms are superimposed on it. Present erosion and sedimentation owing to the Pliocene-Pleistocene uplift is unduly high, with the result that estimates of time based on the present rate of erosion are much too short. Barrell would further increase the time by restricting the area of deposition to the zone immediately below the local base level, and making the accumulation dependent on

upward oscillations of the base level or downward oscillations of the bottom.

In connexion with the rate of sedimentation and its bearing on the age of the earth, it is apparent that the intimate structure of the stratified rocks must be looked to for data bearing on the problem. To this end the character and mode of formation of these rocks are now receiving an increasing degree of attention. A better understanding of sedimentation is being obtained by direct observation on the formation of modern sediments, determination of the precipitating value of algae and bacteria, studies on coral reefs, deep-sea investigations, studies on colloidal solutions, investigations of chemical deposits, and a better appreciation of the value of facies and vegetal terrestrial deposits. Direct investigation of the rocks themselves is leading to an increased use of the petrographic microscope and of analytical methods. Secondary features of stratified rocks are receiving greater attention, horizontal transitional stages are better understood, and the relationship of strata to sea invasions has led to a fuller appreciation of the value of palæogeography.

THE ORIGIN AND INTERIOR OF THE EARTH.

The question of the earth's origin is evidently closely related to the problem of its age. Although geologists are inclined to disclaim this aspect of the subject, I feel that it cannot be disregarded under the title of this address. The interior of the earth is beyond direct observation; the deepest mines and bore-holes scarcely penetrate the outermost skin. Certain fundamental facts, however, may be taken as established. The interior is hot, rigid, and heavy (sp. gr. 5.6 as compared with 2.7 for the known exterior); the accessible exterior is composed of elements common to the universe. Beyond this all is vague and speculative.

It is worthy of particular emphasis, however, that while the earth as a whole acts as an almost perfectly rigid body, the external envelope with which we are familiar is by no means rigid. Adjustments have taken place throughout all geological time, and I need not quote evidence that they are still taking place. The acquisition of perfect rigidity by the globe is to be regarded as a tremendous calamity. This condition attained, the universal deluge is within sight geologically speaking, and the end of the present order of things must inevitably ensue. Earthquakes, therefore, are not to be regarded as unmixt calamities; they are evidence that the fatal total rigidity has not yet been attained.

It might be asked if there is any evidence in geological history of an approach to a condition of total rigidity or of a tendency in this direction. There can be little doubt that pre-Cambrian events were on a scale seldom, if ever, attained in later time. Cambrian and Ordovician transgressions of the sea were also on a grand scale, but later movements, on the whole, seem to have been smaller and more local in their expression, although there were notable exceptions as the Tethys sea in Europe, the great invasion of the Coloradoan geosyncline in Upper Cretaceous time in North America, the tremendous volcanic activity of the Miocene, and the grand epoch of mountain-building in the Pliocene and Pleistocene.

The general conclusions seem to be that the earth is not showing a trend towards rigidity, but that earth movements and vulcanism are becoming less profound in scope and less widespread geographically, the average of activity being maintained by more frequent recurrence.

EARTH MOVEMENTS AND ADJUSTMENT.

The causes of earth crumpling and the dynamic laws which govern the phenomena are subjects well within my theme, but their consideration would lead me to undue length. Earth movements, of necessity, are bound up with theoretical considerations of the earth's interior. Whether earth crumpling is due to loss of terrestrial heat and consequent contraction of the nucleus, or whether the modern concept of isostasy offers a better explanation, there must be a downward limit to terrestrial disturbances. This limit has been placed at 113.7 kilometres and termed the "depth of compensation."

It is obvious that a consideration of this subject would lead to a discussion of land forms and their influence on human activities—definition of nationality, physiographic control, distribution of faunas, and countless other effects, all of which extend beyond the realm of technical geology and form part of a general education if they are not "cultural" in the narrower sense. There is, however, one great lesson to be derived from the study of earth movements that bears on the general scheme of things and is worthy of especial mention—the marvellous continuity of conditions.

The diameter of the earth is about 8000 miles and the maximum of relief of the lithosphere about eleven miles, approximately 0.14 per cent. Oceanic waters have filled the depressions and continental masses have risen above the water-level—a condition that has maintained throughout all time in the opinion of most geologists. The present area of the land is 27.7 per cent of the whole terrestrial surface, and the average height above sea-level of the continental masses is only 2120 feet according to de Lapparent. It is apparent that the actual volume of that part of the lithosphere which projects above sea-level is extremely small when compared with the volume of the whole globe.

It is well known that the power of erosion is sufficiently great to have reduced this relatively small mass to sea-level time and time again throughout the long course of the geological ages. Nevertheless, it is confidently believed that this result has never been entirely achieved. Rejuvenation has kept pace with erosion throughout the hundreds of millions of years that the earth has endured. In my opinion this marvellous nicety of adjustment between two great sets of opposing forces is one of the major lessons of geology. Is it a mere coincidence or is it evidence of design?

CLIMATE.

Climatic change must be regarded as an ever-present factor. It is highly probable that variation in climate will greatly affect the activities of the human race within a measurable number of years, and it is not impossible that the sites of our present centres of civilisation will be buried under glaciers and that a new civilisation will occupy, under a genial climate, the present inhospitable regions around the poles.

Despite the changes in any given locality, the continued existence of life is sufficient evidence that the whole globe has not experienced, from the earliest geological time, any very great universal change in climate. Grüner has proved to the satisfaction of most geologists the existence of algæ in the Keewatin of Minnesota. The great masses of limestone with disseminated graphite of the Grenville are at least suggestive of life, and Moore has brought forward convincing evidence of algæ in the Animikie of Belcher Islands in Hudson Bay. Both the Archæozoic and the Proterozoic, therefore, were warm enough to permit organisms to exist despite the intervening event of an ice age in the Huronian.

Wonderful have been the changes in climate and far-reaching their effects, but truly marvellous has been the continuity of a range of temperature permitting the existence of life from the very dawn of earth history to the present moment. Nothing short of a cosmical catastrophe can alter a condition that has maintained for nearly two thousand millions of years. Surely if culture is the cultivation of the spirit, the contemplation of geological climate should lift the mind above the mere material into the realm of the philosophical and the spiritual. If the continuity of the observed range of temperature is due to a single factor—solar energy—the endurance of that energy is a marvellous thing. If the observed climatic continuity is a composite result due to various sources of energy, it is still more marvellous.

THE STUDY OF GEOLOGY.

Whatever satisfaction is to be derived from the acquisition of knowledge, there is always a discouraging factor in the realisation of our limitations. Owing to the complex nature of the subject and the vast number of facts involved, the study of geology is peculiarly effective in this respect, and cannot but tend to a humble attitude of mind. Another potent influence to this end is the realisation of the mistakes that have been made, even in the basic principles of the science. From the fantastic theories of the cosmogonists arose eventually the doctrine of catastrophism; this conception yielded to uniformitarianism, and to uniformitarianism was added the doctrine of evolution. Le Conte described Darwin as a uniformitarian evolutionist. To-day uniformitarianism is being questioned seriously from both the inorganic and the organic points of view. We are swinging back to a conception of a milder catastrophism variously expressed as rhythm, diastrophism, and so on. The necessity of drawing conclusions from doubtful or insufficient evidence is an ever-present antidote for dogmatism. Many of our conclusions are merely inferences subject to revision in the light of further evidence.

To humbleness and caution I would add a conviction of theism as a result of the study of geology. I fear to venture on dangerous ground, but I must be allowed the opinion that materialism offers no adequate explanation of the wonders of geology. With revealed religion I am not here concerned, but I believe that the inconceivably long gradient that has led ever upward to the mentality of man has not been traced without design, and I see no reason why that gradient should terminate. I look, rather, to its upward continuation to even greater heights beyond.

Some Issues in the Theory of "g" (including the Law of Diminishing Returns).¹

By Prof. C. SPEARMAN, F.R.S.

THEORY OF "G."

THE following communication treats of certain points in a theory which has become known as that of Two Factors or of *g*. At the present time this theory has undergone very elaborate development. The mental testing from which it originated lay at first as a foreign intruder in the midst of general psychology. Its opponents—and these were not few—regarded it as an excrescence that should be forthwith cast out; and even its best friends wondered how the general psychology was ever going to assimilate it. But, seemingly, neither of these solutions is happening to any great extent. The mental testing has waxed larger and established itself more firmly than ever *without* much assimilation with the current general doctrines; indeed, it seems more likely, cuckoo-wise, to eject *them* from the psychological nest. In particular, the theory of *g*, which arose from the mental tests, has now managed to spread itself over the whole of the cognitive side of psychology, and not impossibly it will soon extend its scope over into the supplementary or conative side.

For the present I do not propose to depict the whole elaborate theory of *g* even in outline. Such an attempt is reserved for a work that will appear shortly. But a very few words may be allowed here to indicate its essential foundation as unwaveringly preserved from the very beginning. This consists in the theorem, that the measure of *every different ability of any person can be resolved into two factors, of which the one is always the same, but the other always independent*. Suppose, for example, that any person undergoes a mental test and obtains seventeen marks for it. The theory asserts that this can actually be divided into two parts, say eleven and six, such that (on reduction to comparable units) the eleven re-occurs for this person in every other test however widely different, whereas the six is each time replaced by some other number independently.

The establishment of this doctrine falls into three distinct phases. The first is to ascertain what are the conditions under which the measures of any ability admit of such division into two factors. We may note that this phase has often been erroneously called an assumption or hypothesis. It is really nothing of the kind, but simply a mathematical demonstration. Given the said conditions, then the divisibility into such two factors must necessarily occur, just as, given that a triangle has all its angles equal, then it must needs also have all its sides equal. The second phase is to find out where, if at all, the conditions are actually fulfilled. Again, no assumption or hypothesis of any kind is involved; the matter is nothing more than observation of fact.

Then comes the third and last phase, that of supplying the factors with some plausible interpretation. Here the most cautious procedure, and one that goes not an inch beyond what has really been proven, is simply to denote these factors by the non-committal letters *g* and *s* respectively. Any interpretation going beyond this can only, in our present state of knowledge, have a provisional value; it can serve to inspire further

investigation, by which it will assuredly suffer much modification itself. With this reservation, then, the hypothesis at present seeming most helpful and suggestive is that the *g* measures something of the nature of an "energy" derived from the whole cortex or wider area of the brain. Correspondingly, the *s*'s measure the respective efficiencies of the different parts of the brain in which this energy can be concentrated; they are, so to speak, its "engines." Whenever the mind turns from one operation to another, the energy is switched off from one engine to another, much as the power supply of a factory can be directed, at one moment to turning a wheel, at the next to heating a furnace, and then to blowing a whistle.

RECENT CONFIRMATION.

So much to serve as a general description of the doctrine. I will now bring to your notice some recent work whereby its foundations have received additional strengthening, both on the side of mathematics and on that of actual observation.

To take the former first, the earlier researches had only shown what conditions are *necessary* for the divisibility into the two factors. Later investigation has proved that these conditions are also *sufficient*. In other words, we now know, not only that under the said conditions the divisibility into two factors may possibly occur, but also that it inevitably must do so. I stress this point because some of the recent writing on the subject appears to make the contrary and mistaken statement that, even when the conditions are satisfied, still the divisibility either may or may not ensue.

As to the precise nature of these conditions, they are based upon the coefficients of correlation. Such coefficients, as is now generally understood, consist in numbers that indicate just how closely any two abilities or other characters tend to vary in proportion to one another. They are usually symbolised by the letter *r*. Thus, r_{12} would denote the degree that any ability 1 tended to vary from individual to individual proportionately to some other ability 2. Now, the conditions for the divisibility into the two factors reduce themselves to the simple equation:

$$r_{12} \cdot r_{34} - r_{13} \cdot r_{24} = 0.$$

Here the value on the left is called the tetrad-difference. When such tetrad-differences remain equal to zero throughout any set of abilities, whichever of them may be taken as 1, 2, 3, and 4 respectively, then and then only, each of these abilities can be divided up into two factors such as we have described. Should any one ask *why* this particular equation should have the virtue of necessitating such a divisibility, I can only answer that it is but one out of all the miracles of mathematics. I never cease to be astonished at it myself. For further elucidation, reference must be made to the mathematical proof (Proc. Roy. Soc., 1923).

So far we remain in comparatively smooth waters. The chief difficulty arises when we turn to what are known as the errors of sampling. Suppose you wanted to know whether a field of potatoes was bearing a good crop. You walk about, pulling up a plant here and

¹ Presidential address delivered at Southampton on August 27 before Section J (Psychology) of the British Association.

there This gives you some approximate knowledge, but not an exact one. For all you can tell, you may have been exceptionally lucky or unlucky in your selection. The degree of discrepancy between the average size of the potatoes actually pulled and that of the whole field is your error of sampling. Now, just the same befalls any coefficient of correlation between two abilities. You want to know how closely these two go together with people of some general class. You pick out, say, 100 of these people; but just in this 100 the correspondence between the two abilities may happen to be rather higher or lower than on an average throughout the entire class. Your coefficient of correlation will have an error of sampling; and our preceding tetrad-difference, being made up of correlational coefficients, will have one also.

Now, the latest advance in the theory of g consists in showing the general magnitude of the tetrad-differences that will arise from the sampling errors alone, even when the true magnitude is always zero. This value of the tetrad-differences to be expected merely from sampling was published last year (*Brit. J. Psychol.*).

Having got this theoretical value, there remains the momentous step of comparing it with the median value which is actually observed. The theory of g stands or falls according as these two values are or are not found to agree.

This step so fraught with fate has now been taken. To avoid all danger of personal bias, no work of my own was chosen for this crucial decision, but that of an investigator who, more than all others, had shown himself unsympathetic with the doctrine of g . Here is his table of correlations as published by himself:

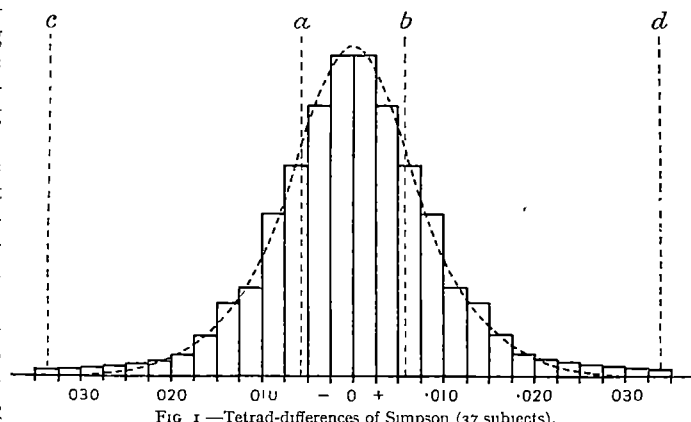
Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Completion		98	94	79	62	91	71	54	78	88	55	42	33	25
2 Hard Opposites	98		84	80	64	81	79	70	73	74	52	43	26	25
3 Memory words	94	84		62	55	82	49	56	73	71	53	40	28	21
4 Easy Opposites	79	80	62		57	52	68	53	42	56	45	29	38	48
5 A Test	62	64	55	57		55	54	73	39	51	39	59	25	22
6 Memory pass	91	81	82	52	55		53	57	59	66	54	31	28	19
7 Adding	71	79	49	68	54	53		45	39	47	51	57	17	25
8 Geomet forms	54	70	56	53	73	57	45		35	49	34	56	25	25
9 Learn. pairs	78	73	73	42	39	59	39	35		69	36	29	26	09
10 Recog forms	88	74	71	56	51	66	47	49	69		44	37	34	28
11 Scroll	55	52	53	45	39	54	51	34	36	44		31	19	27
12 Compl words	42	43	40	29	59	31	57	56	29	37	31		21	07
13. Estim length	33	26	28	38	25	28	17	25	26	34	19	21		24
14. Drawing length	25	25	21	48	22	19	25	25	09	28	27	07	24	

To work out all the tetrad-differences was no light undertaking, since they run to the number of 3003. The calculation of these was entrusted to the competent hands of Mr. Raper. When all was reported ready we met, I carrying the "probable error" of the tetrad-differences—that is, the median value that should by theory be expected to arise from sampling alone, he bringing the average value of the 3003 tetrad-differences actually derived from the above table. My number was 0.061. His was 0.074; this, in order to get from the average to the median, had to be multiplied by the well-known constant 0.845, whereby it came finally to 0.062.

It may be of interest to survey the entire frequency distribution of the values concerned. The dotted curve (Fig 1) shows the relative frequencies that should be expected from the sampling errors alone. About half should lie between a and b ; extremely few beyond

c or d . The continuous rectangles show the relative frequencies that actually occurred. A better agreement of a theoretical frequency curve with one of actual observations does not, I venture to say, exist throughout psychology, or perhaps even throughout statistics.

The preceding result may be instructively compared with another one. The doctrine of Two Factors, as is only proper, has had to make its way in the face of strong resistance. But the latter has curiously adopted two contrary lines of defence. One is to question whether the mathematical criterion would really be satisfied by actual observation; and this doubt, I hope, has been met by the facts just cited. But the other opposition has instead asserted that *any* ordinary table of positive correlations would naturally satisfy it, so that such satisfaction must be devoid of peculiar significance. Recently this second line of opposition



has acquired much greater vitality, in that a table of correlations has now been brought forward as an actual example, it is not derived from mental but from physical traits, and yet, it is said, exhibits a quite similar character. Here is the table:

	1	2	3	4	5	6	7	8
1 Area of ossification		88	60	62	43	31	25	26
2 Ratio of ossification	88		52	58	41	21	24	29
3 Height	60	52		69	44	51	45	11
4 Weight	62	58	69		65	39	40	83
5 Chest girth	43	41	44	65		59	36	69
6 Lung capacity	31	21	51	39	59		46	26
7. Strength of grip	25	24	45	40	36	46		14
8 Nutrition	26	29	11	83	69	26	14	

Let us, then, look at the median tetrad-difference derived from this table and compare it with the probable error to be expected from sampling alone; the respective values are 0.089 and 0.011; that is to say, the actually observed value is no less than eight times greater than what theory demands. Here again we can examine the whole frequency distribution.

The explanation of the figure (Fig. 2) is the same as in the preceding case of Simpson (Fig. 1). Between the curve showing the values to be expected from the errors of sampling and the rectangles showing those actually observed there is this time no agreement whatever.

LAW OF DIMINISHING RETURNS.

So much for the strengthening of the doctrine. I will now proceed to describe a rather curious matter that has arisen in the course of its elaboration

Since the very beginning it has been known that the two factors, *g* and *s*, the energy and the engines, may have widely different relative importance, according to the particular mental operation involved. With some operations the superiority of one person over another is preponderantly decided by their respective amounts of the energy. With other operations, on the contrary, the dominant factor is the engine.

Subsequent research, moreover, has been gradually outlining the cases which incline in one or the other direction. Thus the energy is in general more important for operations that are composite, the engines for those that are monotonous. This is natural enough. The composite operation really involves several different engines; the superiority that an individual may happen to have in any one of them will tend to be neutralised in the average of them all; but a superiority in the energy will make itself felt in each, and thus obtain cumulative influence. Again, the energy is less and the

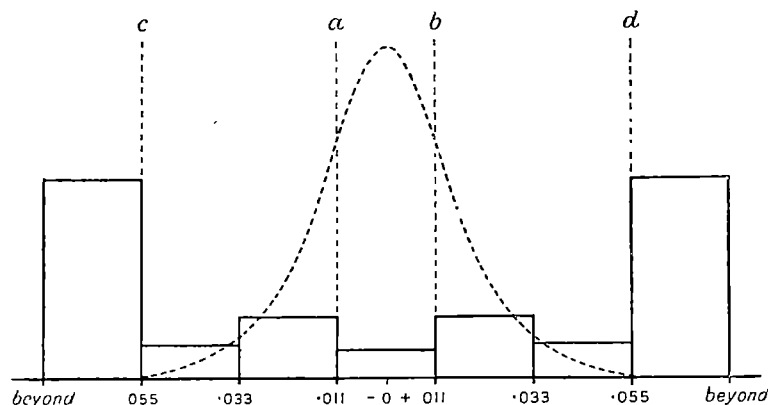


FIG. 2.—Tetrad-differences of A. Gates (115 subjects)

engine more influential whenever the operation depends much upon the efficiency of some sensory or motor apparatus. This, too, is natural enough; for such apparatus obviously constitutes a part and parcel of the engine. Yet again the energy has been found to lose in importance as compared with the engine in proportion as the operation tends less to create new mental content and more to reproduce old.

The point which I wish to bring forward in this place is that the relative influence of the energy and the engines changes largely with the class of person at issue. The most drastic example of this is supplied by a comparison between normal children and those who are mentally defective. The work of Abelson may be quoted, where the same tests were applied by the same experimenter to both classes. The correlations obtained for the two respectively are as follows:

NORMAL CHILDREN. (78 CASES)												
	1	2	3	4	5	6	7	8	9	10	11	12
1. Opposites . . .	75	78	71	62	64	72	78	57	40	46	33	
2. Observation . .	75	72	72	58	60	58	67	56	38	56	52	29
3. Absurdities . .	78	72	53	53	41	44	79	68	41	46	34	29
4. Memory sentences	71	58	53	54	61	54	37	54	55	19	43	
5. Crossing o's . .	62	60	41	54	73	48	54	38	36	52	35	
6. Geometrical figs.	64	58	44	61	73	45	48	30	42	48	35	
7. Discrim. length .	72	67	79	54	48	45	56	49	30	31	06	
8. Crossing patterns	78	56	68	37	54	48	56	39	21	27	18	
9. Memory form . .	57	58	41	54	38	30	49	30	24	31	29	
10. Tapping	40	56	46	55	36	42	30	21	24	29	18	
11. Strength of grip	46	52	34	19	52	48	31	27	31	29	28	
12. Interpret. pictures	33	29	29	43	35	35	06	18	29	18	28	
Mean = 0.466.												

DEFECTIVE CHILDREN (22 CASES.)

	1	2	3	4	5	6	7	8	9	10	11	12
1. Absurdities . . .	10	10	10	98	97	10	10	10	98	94	94	79
2. Opposites	10	97	95	87	91	85	76	85	87	70	72	
3. Crossing patterns	10	97	91	80	88	68	92	74	78	76	67	
4. Crossing o's . . .	98	95	91	85	77	84	67	76	81	73	55	
5. Memory sentences	97	87	80	85	73	90	68	88	65	78	68	
6. Observation . . .	10	91	88	77	73	76	83	71	86	59	65	
7. Memory form . . .	10	85	68	84	90	76	65	67	70	77	75	
8. Interpret. pictures	10	76	92	67	68	83	65	74	80	80	59	
9. Geometrical figs .	98	85	74	76	88	71	67	74	65	60	62	
10. Discrim. length .	94	87	78	81	65	86	70	80	65	51	45	
11. Tapping	94	70	76	73	78	59	77	80	60	51	45	
12. Strength of grip	79	72	67	55	68	65	75	59	62	45	61	
Mean = 0.782.												

All round, obviously, the correlations are much smaller in the case of the normal children. This indicates that with these the influence of the energy has gone down and that of the engines has correspondingly gone up.

Compare next young children with those that are older. Here I may quote from the admirable work of Prof. Burt. Applying his test of reasoning to numerous children of different ages, he obtained the following correlations with the estimates of the teachers (in general, the older children show smaller correlations):

Ages . . .	10-11	11-12	12-13	13-14
Correlations .	78	81	64	59

No less marked is this tendency on comparing children with adults. As examples may be taken the correlations obtained by Otis and Carothers respectively for what appear to have been similar tests in each case.

Test	Correlations with <i>g</i> , Otis, grades IV-VIII	Carothers, students.
Analogies	0.84	0.71
Completion	0.88	0.53
Directions	0.86	0.45
Digits, memory . . .	0.41	0.22

Now these changes obviously follow a general rule. The correlations always become smaller—showing the influence of *g* to grow less—in just the classes of person which, on the whole, possess this *g* more abundantly. The rule is, then, that the more energy available already, the less advantage accrues from further increments of it. This is a well-known property of engines in general. Suppose that a ship at moderate expenditure of coal goes 15 knots an hour. By additional coal the rate can readily be increased another 5 knots. By doubling the addition of coal, however, the additional knots will certainly not be anything like doubled. This relation is observed not only in engines, but also widely elsewhere. In the science of economics, for example, it is expressed in the well-known law of diminishing returns. A moderate amount of capital spent on a given piece of land will produce a certain return; but on adding further doses of capital the returns will not increase proportionately.

In our psychological case of different classes of persons there enter no doubt various complications which render the theoretical interpretation more dubious. Above all, there is the fact that the classes better endowed with *g* have usually undergone more or less selection. For example, the university students of Carothers had been cleared of the weaklings who could not matriculate. This in itself would tend to lower all correlations due to *g*. However, such facts would seem capable of accounting for only part of the phenomenon,

not for the whole. There remains enough over to suggest a genuine law of diminishing returns for mental as for material processes.

COROLLARY OF INDEPENDENCE.

The next and final point to be raised here is a corollary of what has been said. Since a great many abilities depend almost entirely upon the efficiency of the engines involved and this efficiency varies independently from individual to individual, we may conclude that these abilities themselves vary almost independently from individual to individual.

This theorem has, indeed, been called into question. Some authorities have asserted the existence of a general "sensory level" of ability, so that the persons who are successful at one kind of sensory performance will tend to be so at others also. Other writers have adopted a similar position as regards what they call "practical" ability; persons are taken to be either endowed or not endowed with this all round. But no such position would appear to be supported by the available definite evidence. Dr. McCrae, for example, has recently examined the correlations between different tests that have been entitled those of "performance." These, even among persons of comparatively low status, proved to be, in fact, almost independent of each other. Still more striking has been the result of a very valuable investigation by Mr. Philpott. He undertook to test the discrimination of length, a power which obviously possesses great importance in many spheres of industry. He wisely tested this discrimination in two different ways. First, he showed pairs of lines and made the subjects judge which was the longer; and then he gave them single lines and made them, in each case, draw another line as nearly as possible of the same length. As result, these two performances, that seemingly are but manifestations of one and the same power, turned out to be almost entirely independent. Those who were best at judging between the two lines already drawn did not, to any appreciable extent, excel at making a second line equal to a given one. Quite similar results were obtained for the discrimination of angles, as also for perceiving whether a line is straight or not.

Accepting, then, the conclusion that an immense number of abilities vary from one individual to another almost independently of each other, what is the practical result? Let us try to get a notion how such abilities of any person must be distributed in respect of excellence. By all experience, and also by statistical theory into which we cannot enter here, the great bulk of his abilities will tend to be mediocre; that is to say, they will be near the general average of his class. A fair number will be distinctly above this average, and a fair number below. A small number will be much above; and so also below. The whole frequency distribution will, in fact, have a bell-like shape similar to that which was shown by the curves of the tetrad-differences to be expected from sampling errors. At the extreme ends of the distribution will lie a very small number of performances for which the person is, on one side a genius, and on the other an idiot. Every normal man, woman, and child is, then, a genius at something as well as an idiot at something.

It remains to discover *what*—at any rate in respect of the genius. This must be a most difficult matter, owing to the very fact that it occurs in only a minute proportion out of all possible abilities. It certainly cannot be detected by any of the testing procedures at present in current usage, but these procedures are capable, I believe, of vast improvement.

The preceding considerations have often appealed to me on looking at a procession of the unemployed, and hearing some one whisper that they are mostly the unemployable. That they are so actually I cannot help concurring. But need they be so necessarily? Remember that every one of these, too, is a genius at something—if we could only discover what. I cherish no illusion, indeed, that among them may be marching some "mute inglorious Milton, some Cromwell guiltless of his country's blood." For these are walks in life that appear to involve a large amount of *g*. But I am quite confident that every one of them could do something that would make him a treasure in some great industrial concern; and I see no reason why some should not have even become famous, in such occupations, for example, as those of dancers, jockeys, or players of popular games.

Radiometric Measurements of Stellar and Planetary Temperatures.

By Dr. W. W. COBLENTZ, Bureau of Standards, Washington, D.C.

THE recent measurements of planetary radiation and planetary temperatures, especially of Mars, had their beginning in the first really successful tests at the Lick Observatory, Mt. Hamilton, California, in July 1914, when thermo-couple measurements were made on 112 celestial objects, including 105 stars, down to magnitude 6.7, and the planets Venus, Mars, Jupiter, and Saturn. (Bureau of Standards Sci. Paper, § 244, 1914.) The experimental procedure then employed, and the results obtained, have foreshadowed, in an unforeseen manner, practically everything that has been accomplished since then.

During the world strife and confusion that occurred in the meantime, nothing further was accomplished until the fall of 1921, when, at the invitation of the Lowell Observatory, I was given a further opportunity to try out a new method of measuring stellar tempera-

tures by means of screens of quartz, water, etc., which separated the incident radiation into components containing radiation of the following wave-lengths: 0.3 to 0.43 μ ; 0.43 to 0.6 μ ; 0.6 to 1.4 μ ; 1.4 to 4.1 μ ; and 4.1 to 12 μ . In this manner the distribution of energy in the spectra of 16 stars was determined, thereby obtaining for the first time an insight into the radiation intensities in the complete spectrum of a star.

From a comparison of the observed stellar spectral radiation components with similar data, calculated for a black body at various temperatures, it was found that the stellar temperatures range from 2500° to 3200° K for red stars, up to 14,000° K or even higher for blue stars, which is in good agreement with other methods of estimating stellar temperatures.

Since then Pettit and Nicholson, using similar thermo-couples and a transmission screen of water attached to

the great 100-inch reflector of the Mt. Wilson Observatory, have been able to study long period variable stars of visual magnitude down to magnitude 9.2 and temperatures below 2000° K. In the meantime, Abbot has succeeded in measuring the distribution of energy in the spectrum of a number of the brightest stars, and has obtained temperatures in good agreement with those previously observed by the writer, using a thermocouple and transmission screens. Furthermore, using the writer's radiometric measurements, and assuming that the radiation from these stars is similar to that of a black body, Stetson has computed stellar diameters which are in good agreement with those measured directly with an interferometer.

From the foregoing results it appears that the outlook for the thermocouple as a useful instrument in stellar radiometry is very promising: (1) as a device for estimating stellar diameters; and (2) for determining the temperature of stars that are too small to measure the spectral energy distribution directly, thus supplementing the work of Abbot. The only discrepancy is perhaps in the published measurements of the radiation from Sirius. There seems to be something elusive about this star. Back in 1914 it was on the list for measurement; but because of daylight and low altitude no attempt was made to measure it. In 1921 a series of radiometric measurements gave a water-cell transmission of about 70 per cent. (in Bur. Stds. Sci. Paper, § 438, is given the uncorrected value, 65 per cent.). This would indicate that the spectral type of the companion star of Sirius is lower than A—perhaps below type F or down to type K. Owing to an uncertainty in some recent radiometric measurements on this star, further work must be undertaken to disprove or verify these results.

The results of 1921 were so promising that the Lowell Observatory extended the invitation to continue the investigation in 1922, especially of planetary temperatures, in preparation for the opposition of Mars in 1924.

In all these measurements of planetary radiation, use was made of the 40-inch Lowell reflector with focal lengths of 220 inches and 640 inches; Mr. C. O. Lamp-land, astronomer at the Lowell Observatory, collaborating. The measurements of 1922 and of 1924 are in agreement in showing that the planetary radiation emanating from Jupiter and from Saturn, and transmitted by our atmosphere, is very small, while the planetary radiation from Venus, Mars, and the moon is, relatively, very intense. The radiometric measurements made in 1922 indicated that about 30 per cent. of the total radiation emanating from Mars is of planetary origin, as compared with 80 per cent from the moon. From the fact that the surface temperature of the moon is estimated to be considerably above 100° C., the writer estimated (Bur. Stds. Sci. Paper, § 460, 1922) that the temperature rise of the surface of Mars is considerable—perhaps so high as 10° to 20° C.

From the water-cell transmissions obtained by us in 1922, Menzel (*Astrophys. Jour.*, 58, p. 65, 1923), using Russell's formula, calculated the following temperatures: Venus, 50° C.; Jupiter and Saturn, -110° C.; and the moon, 120° C. From the water-cell transmissions of the radiation from Mars, observed on June 15 and 18, 1922, his calculations gave temperatures of -5° C.

and -9° C. respectively, the higher value being for the smaller receiver, which intercepted 0.4 of the diameter of the planetary disk. From the large temperature gradient observed in 1924, extending from the equator to the poles and the limbs of the planet, it is evident that the highest temperature, -5° C., is an average value, which should be corrected for latitude. This would raise Menzel's values to 5° C., or perhaps even higher, when corrected for non-black body radiation.

Using our data observed in 1924, Menzel has calculated an average temperature of -30° C. for the whole disk of Mars. The temperatures of the apparent centre of the disk ranged from -5° C. on the bright areas to 22° C. on the adjacent dark areas, the predominating values being 6° to 9° C. The true temperatures would be about 10° higher, or 15° to 20° C. The temperatures derived by this method of reducing the data are in good agreement with those obtained by three other methods, all of which indicate conclusively that the equatorial temperature of Mars, at perihelion, was considerably above 0° C.

The planet Venus is one of the most interesting cases met with in radiometric observations. The surface of the planet is hidden by clouds, and its period of rotation is undetermined. Hence the thermocouple radiometer appears to be a means of obtaining further information on this question. For it was found that not only does the illuminated crescent show the presence of considerable planetary radiation, but the unilluminated part of the disk also emits a large amount of infra-red rays. This raises the question whether the radiation from the dark side of the planet is owing to a rapid rotation. If the period of rotation is long (225 days), then it seems necessary to assume that the surface of Venus is still quite warm, although the highly selective condition of the planetary radiation at $8-12 \mu$ may perhaps be interpreted as due to radiation of the hot gases convected from the illuminated over the dark part of the planetary surface. However, since this involves distances of 800 to 1000 miles over the surface, it seems difficult to reconcile this assumption with the radiative properties of the gases which probably constitute the atmosphere of Venus.

An interesting and important observation is that the intensity of the radiation emitted from near the south cusp in the present position of the planet Venus—both for the dark and the illuminated regions—is greater than that emanating from corresponding points near the north cusp. This may be owing to differences in the surface conditions, as previously observed on Mars. Then, again, it suggests an effect of insolation due to inclination of the axis of rotation, analogous to seasonal changes on Mars and the earth. Further radiometric observations, at different presentations of the planet's surface to the earth, will be required to test this question. If this is seasonal, then it should be possible to establish the position of the axes of rotation of Venus.

From our data observed in 1924, Menzel calculated the following temperatures: Venus, 60° C.; Jupiter, -135° C.; Saturn, -150° C.; Uranus, lower than -185° C.; and the moon, 125° C. These calculations are in good agreement with those based upon our data of 1922, and they are in good agreement with Christiansen's theoretical calculations made long ago, in which he obtained the following values: Venus, 65° C.; Jupiter, -147° C.;

Saturn, -180° C.; Uranus, -207° C.; and Neptune, -221° C.

In the case of Saturn, the observations seem to indicate that the temperature is higher than can be maintained solely by the incident solar radiation. In other words, the interior of the ball of Saturn is still relatively hot. This is in agreement with the views expressed by Poynting twenty years ago, when he made his theoretical calculations of planetary temperatures, obtain-

ing 69° C. for Venus and -38° C. for Mars. As an average value for the whole disk of Mars, Poynting's calculation of -38° C. is in good agreement with our observed value of -35° C.

The observed temperature of the moon, 125° C., is in good agreement with the values assigned to it years ago, by Lord Rosse, 110° C., and more recently by Very, 150° C., by comparison of the lunar radiation against a black body.

Deinosaur Eggs.

By Dr. F. A. BATHER, F.R.S.

THE *Times* published on September 9 an interesting despatch from its Peking correspondent, giving further details of the discoveries in Mongolia by the expedition from the American Museum of Natural History, led by Mr. Roy C. Andrews. The fresh information about the fossil eggs attributed to dinosaurs suggests some comment.

Two of the recent finds are particularly worthy of note. One is a nest of twelve eggs almost perfectly preserved. The eggs were arranged in a circle, with the narrow ends pointing outwards; no doubt the broad end was, as in birds, that which first emerged, but in birds' nests this end of the egg is, as one would expect, directed outwards. Then the eggs are said to have been "in two layers of six each," those of the upper layer presumably alternating with those of the under one. This, if a correct description, suggests that the dinosaur scooped a basin in the sand, and perhaps covered the first layer with sand, as is the habit of the Nile crocodile.

The other find was a nest of five eggs, "smaller than those found two years ago, more elongated, and evidently the produce of another type of dinosaur. The shells are smooth, in contrast to the dimpled surface of the others, and very thin." Are they the eggs of a dinosaur at all? All as yet known have notably thick shells. These might be the eggs of a crocodile or a chelonian. Turtles' eggs are now being fossilised in just the same way in the sand-dunes of Western Australia.

The last question will have to be settled by the study of thin sections. It is strange how little was known two years ago about the structure of egg-shells, whether recent or fossil, of birds or of reptiles. Nathusius alone has studied thin sections of recent egg-shells, describing that of the moa in 1870, and that of a python in 1883. About 1870 also, some Cretaceous fresh-water sandstones in Provence yielded the bones of a reptile and some fragments of egg-shell. The latter and thin sections cut from them were re-studied in 1922 by Dr. Van Straelen and Mr. E. Deneyer of Brussels. The reptile is generally supposed to be some sort of dinosaur, and the eggs are assigned to it with some probability, made stronger by Dr. Van Straelen's later researches, of which a preliminary account was recently issued by the American Museum of Natural History. The following summary is based on the researches quoted and a few more general facts.

The egg of all birds and reptiles, when first formed within the body, is covered with a flexible membrane. At a large number of points in this membrane minute specks of lime appear. Round each of these specks

more lime is gradually added in successive layers like the coats of an onion, thus building up little spheroids. When these spheroids meet one another, they form a complete coating to the egg, so that further layers of lime can be laid down only on the outer side of this. The layers outside any one spheroid thus build up a pile of irregularly prismatic shape and connect irregularly with the layers of the adjacent piles or prisms. On the inner surface of the first-formed coat each spheroid appears as a little hillock or mamilla; so this is called the "mamillar zone." The outer layers form the "prismatic zone." Outside the latter some of the membrane may remain as a "cuticle."

In chelonians the egg-shell is very thin, being composed only of the mamillar zone, with gaps remaining between the spheroids. In snakes the shell is still thin; the prisms are there, but they do not always join up. In crocodiles the shell is thicker than in turtles and in most birds, but the prismatic zone is scarcely developed; spaces, in the form of canals of two sizes, are left at intervals between the spheroids, so that air can reach the developing embryo. All birds have a mamillar zone and a relatively thick prismatic zone. In the *Ratitæ* the shell is thick and the air-canals branch as they near the outside, each ending in a group of pores. In the higher birds the shell is thinner and each canal opens in a single pore.

The dinosaur egg-shells already described by Dr. Van Straelen fall into three groups. In those associated with Protoceratops, from the base of the Upper Cretaceous, very small spheroids form a thin mamillar zone; the thick prismatic layer is traversed by relatively few air-canals, which end in minute pores and are of the same width throughout. In a Mongolian shell thought to belong to a duck-billed dinosaur the spheroids are larger, the pores a little larger, and the canals swell in the middle. In the shell from Provence the mamillar zone is much as in the last-mentioned; but above it are cavities which give rise to straight air-canals of equal bore, ending in pores of 0.1 mm. to 0.2 mm. diameter.

Thus the three types of supposed dinosaur eggs show a general agreement with one another. They differ from the eggs of all other creatures, but present certain resemblances to the eggs of crocodiles and birds, just as one would expect dinosaur eggs to do. We may therefore conclude that they really were laid by the dinosaurs the remains of which are found with them.

In addition to these three types, Dr. Van Straelen has in hand material from other parts of the world, including a probable dinosaur egg from the Oxford Clay of Peterborough and other eggs from the Oolite

of Great Britain. Now Mr. Roy Andrews tells us of one new type, of deinosaurian appearance, and another which is not so obviously deinosaurian.

The question whether all these eggs are those of dinosaurs has its converse: did all dinosaurs lay eggs? This cannot be taken for granted. The eggs of dinosaurs must have been hatched by the heat of the sun or of decaying vegetable matter, and it is natural to find them laid in rocks formed under desert conditions. To lay its eggs a dinosaur must have

trod on *terra firma*. The huge sauropods that lived in the estuaries of Wyoming, Argentina, and Tanganyika can in many cases have climbed on to the land only with great difficulty, and it is even doubtful whether their limbs could have supported their enormous weight out of the water. It may therefore well be that, like the water-inhabiting ichthyosaurs and sea-snakes, these monsters were viviparous. The East African Expedition of the British Museum is not likely to find their eggs in Tanganyika Territory.

Current Topics and Events.

IN the course of an interesting account of the discovery in the Gobi Desert of forty more dinosaur eggs, representing three species, given to the correspondent of the *Times* at Peking by Mr. Roy Chapman Andrews, the leader of the third expedition of the Natural History Museum of New York to Mongolia, which appeared in the issue of September 9, it is stated that implements of a type corresponding to the Azilian period of western Europe have been discovered by members of the expedition. These implements, made of red jasper, chalcedony, and chert, were found under the sand dunes which are characteristic of the district, and include such forms as spear- and arrow-heads, axes and knives, and so forth, of careful workmanship. Pieces of egg-shell of dinosaur and giant ostrich pierced with holes were evidently used for ornament. In a more recent deposit were two fossil skulls with other evidence of a later culture, which is stated to be "probably neolithic," although bronze points are mentioned as among the finds. Other relics of early man found in this area include a few implements of Mousterian type and pictographs illustrating moose, elk, and other extinct mammals of which the relation to the other finds is not specified.

It is obvious that this account of the discovery, apparently of primitive implements of human workmanship, must be received with all reserve until a further and more authoritative account is to hand, but it certainly holds out hopes of the fulfilment of the expectation that this expedition might well find traces of early man in Central Asia. The mention of implements of Mousterian type is of especial interest, coming as it does within a short time of the publication of the evidence for Mousterian man obtained by Fathers Licent and Teilhard de Chardin in Northern China and Mongolia, and the discovery of Mousterian implements associated with a skull of Neanderthal type in Palestine. It is stated that the earlier culture was separated from the later in stratification, but it is necessary that more should be known of the nature and character of the intervening deposits before it is possible to judge how far any wide separation in date is justified. The mention of bronze with the later culture may serve as a reminder that the contemporary use of metal and stone is of frequent occurrence. Stone implements from early sites in Mesopotamia have been known to be classified as Azilian-Tardenoisian until it was pointed out that their coexistence with copper had already been recorded. The geologists of the American expedition,

however, appear to be satisfied as to the antiquity of the early deposits, which they date at somewhere "between 10,000 and 20,000 years old." The further conclusion that primitive man came to Europe from Asia is here made to depend upon a dating of the Azilian culture in western Europe of 7000 years, which is quite possibly too low.

A PLASTER cast of the skull and jaws of *Protoceratops andrewsi* has been received from the American Museum of Natural History and placed on exhibition in the Fossil Reptile Gallery at the British Museum (Natural History). This is not the type, but one of the best skulls obtained in 1923, and is nearly full grown. It is 21 in long, 16½ in high, and 18½ in wide. The skull was found in the Djadochta Sandstone, a desert formation at the base of the Upper Cretaceous in the Gobi desert. *Protoceratops* is supposed to be the dinosaur that laid one kind of the famous eggs. It was herbivorous and one of the primitive Ceratopsia—a group of which *Triceratops* is the best-known example. It is not, however, regarded by the American palæontologists who have studied it as being in the direct line of ancestry of any of the American Upper Cretaceous genera, except perhaps *Leptoceratops*.

HOPES for the regeneration of China which were aroused by the prospect of liberating the funds accruing from the Boxer Indemnity seem likely to remain in abeyance for an indefinite period. The course of events at the moment is more than unfavourable to foreign intervention in domestic affairs, and in education, as in other matters, the Chinese, or at least the more aggressively demonstrative section of the population, do not hesitate to show their desire, and their confidence in their ability, to deal with the situation without outside assistance. In the meantime, the attitude of the students and the prominent part they are taking in the present disturbances lend support to the views of those with first-hand knowledge of the Chinese who are dubious of the advantages for China of an education on even partially Europeanised lines. It may be hoped, however, that this is but a passing phase which affects only the more restless and easily stirred section of the population. It must be remembered that in a country like China, in which, broadly speaking, scholarship has been the only passport to positions of authority, it was almost inevitable that the students would come to taking a hand in times of crisis, and equally inevitable that

here, as everywhere, they would tend to follow a subversive policy.

AN illuminating instance of the students' power in China, though only in what might appear a trivial matter, is given by Mr. Ellsworth Huntingdon, in *Scribner's Magazine* for September, in the course of an article in which he records the impressions of a recent visit to China. He states that the women of Fuchow have been compelled, at the order of the students, to abandon the three small swords it is customary for them to wear in their hair as a symbol of their right to defend themselves in case of need. Although Mr. Huntingdon's stay in the country was not prolonged, and it is notoriously unwise to form a judgment of the people except on something approaching intimate acquaintance, he has grasped certain essentials of the situation. There is conclusive evidence of the overwhelming desire of the Chinese man and woman for education up to the highest grade, but there are difficulties in the way in their desire for self-sufficiency. It is interesting to note that Mr. Huntingdon is in agreement with the view which holds that the use of the Boxer Indemnity money by the United States for educating Chinese outside China has not been an entire success in that it has led to the undue Americanisation of the student—a result disliked by the Chinese and not ultimately beneficial for the individual. The need for preserving what is best in Chinese culture, while allowing full scope to modern intellectual movements combined with high ideals of national welfare, has given rise to a suggested solution in a university which, combining several institutions under a common bond, might still allow free play to the aims and ideals of each of the constituent bodies. This suggestion, it may be noted, is not far removed from that which was put forward in these columns a few months ago in discussing the possibility of a scheme of co-operation between Great Britain and China.

THE decision of the Pharmaceutical Society of Great Britain to establish pharmacological laboratories for the testing of drugs to which the provisions of the Therapeutic Substances Act apply, namely, drugs the purity of which cannot adequately be tested by chemical means, has been advanced an important step by the announcement that applications are invited for the post of Director. The institution of the laboratories has been decided upon by the Council of the Society in order to afford opportunities for research in physiological methods of drug assay, to meet the demand for standardisation of therapeutic substances which will come from manufacturers, who for various reasons may not be prepared to undertake the standardisation contemplated by the new Act in their own laboratories, and also to afford opportunities for advanced students of pharmacy to receive training in the work. The Pharmaceutical Society has recently revised its examination regulations, and pharmaceutical students who have obtained the Society's qualification of pharmaceutical chemist, either directly or through the recently instituted

degree of Bachelor of Pharmacy of the University of London, will be able to take advantage of the opportunities for advanced work provided by the laboratories and should eventually be able to meet the demand for persons with knowledge of physiological standardisation which will follow from the operation of the new Act. The project has the complete approval of the medical authorities, and among the members of the committee which is advising the Council of the Society on the appointment of a Director and on the lines upon which the laboratory should be organised are Sir Humphry Rolleston, President of the Royal College of Physicians, representing the British Medical Association, Sir Nestor Tirard, representing the General Medical Council; and Dr H. H. Dale, representing the Medical Research Council. The Ministry of Health and the Medical Research Council have given the project their approval and support from the beginning, and it is felt that the laboratories will not only achieve their immediate objects in connexion with the Therapeutic Substances Act, but will also make important contributions to the advance of medical science.

THE Palæontologische Gesellschaft, an international society of palæontologists, will meet at Weimar in Thuringia on September 24-29, under the presidency of Prof. J. F. Pompeckj of Berlin. The organising secretary is Prof. Soergel of Tübingen, who also will lead several of the excursions. These include visits to travertine quarries near Ehringsdorf, where relics of Neanderthal man have been found; to old gravels of the River Ilm, with their vertebrate and cultural remains; to the Bunter sandstone of Berka, which shows worm-burrows and tracks of *Chirotherium*; and to the Muschelkalk of Jena, besides the museums in Weimar and Jena. Among papers announced are: Prof. O. Jaekel, "The Problem of the Skull, a Memorial to Goethe's Morphology"; Prof. Scheide-mantel, "The Monuments of Weimar", and Dr F. A. Bather, "Arenicoloides—a Suggestion," this last bearing on the worm-burrows of Berka.

At a recent meeting of the Aero Club of Norway, Lieut. R. Larsen outlined Captain R. Amundsen's plans for a polar flight next year. According to a report in the *Times*, Captain Amundsen has purchased from the Italian Navy a semi-rigid airship which was built in 1924 and has proved successful on several long flights. It has a cubic capacity of 670,000 cubic feet and a length of 328 feet. Three engines, each of 250 h.p., give it a maximum speed of 250 miles an hour. The crew will number sixteen, including Captain Amundsen and Signor Nobile, the constructor of the airship, who will act as navigating officer. At the beginning of 1926 the airship will fly from Rome to Pulham and thence, after overhauling, to Vernes, near Trondhjem, and if circumstances are favourable, direct to Spitsbergen. The final start will be made from King's Bay in April or May. The cruising radius of the airship is 3725 miles, and the voyage across the pole is 2235, which it is hoped will be completed in about fifty hours. Mooring masts are being erected at Vernes and at King's Bay.

DR ALEŠ HRDLIČKA, of the Smithsonian Institution, is expected to make a short stay in England towards the end of September on his return journey to the United States after visits to India, Australia, and South Africa. The object of Dr. Hrdlička's journey to these countries was to investigate on the spot the evidence bearing upon the problems of early types of man. While in South Africa he visited the famous Broken Hill Cave in which the remains of Rhodesian man were discovered, and in examining the deposits, was fortunate enough to discover further fragments of human skeletal remains. He proposes to exhibit these at a meeting of the Royal Anthropological Institute, and to submit to the fellows of the Institute the conclusions at which he has arrived from his examination of the deposits in the caves. Dr. Hrdlička's intention, appropriately enough, is to hand these bones to the British Museum (Natural History), where they will take their place with the remains of Rhodesian man.

THE twenty-fifth anniversary of the foundation of the Mond Nickel Works was celebrated on September 12 at Clydach, Glamorganshire, when Sir Alfred Mond, chairman of the Company, unveiled a bronze statue of his father, Dr. Ludwig Mond, F.R.S., who died on December 11, 1909. Dr. Ludwig Mond's name is connected more particularly with the manufacture of alkali and alkali products. In the late 'sixties of last century, he settled at Winnington in Cheshire, where, with the late Sir John Brunner, Bart., the firm of Brunner, Mond and Co. was built up for the manufacture of soda by the Solvay or ammonia-soda process. Much of the success which the firm achieved was due to the genius of Dr. Mond. The nickel works at Swansea arose out of the discovery, in collaboration with Langer and Quincke, of the group of compounds now known as the metallic carbonyls. This work in an abstract field of research was, with Dr. Mond's characteristic aptitude for seeing practical applications, quickly turned to account, and a process developed for the extraction of nickel from its ores. Dr. Mond will also be remembered as a most generous benefactor of science. The Davy-Faraday Laboratory at the Royal Institution and the International Catalogue of Scientific Literature are two specific examples of his munificence, though practically every movement in his day for the advance of physical or chemical science owed much to him and to his wise and inspiring counsel. Dr. Mond was elected a fellow of the Royal Society in 1891, and on the death of his widow in 1923, the Royal Society and the University of Heidelberg each became a legatee for the sum of 50,000*l.*, the income of which is to be employed for the endowment of research in natural science.

A COLD spell was experienced in England at the commencement of September. The mean maximum temperature for the first 10 days of the month at Greenwich Observatory was 62° 5 F., which is 7° 3 below the average for 65 years, 1841-1905, the mean minimum was 46° 9, which is 3° 9 below the normal. The mean temperature was 54° 7 and 5° 6 below the normal. In 1922, the mean tempera-

ture for September 1-10 at Greenwich was 55° 1; the mean maximum was 64° 0, slightly higher than this year, and the mean minimum was 46° 2, slightly lower than this year. In 1912, the mean temperature for the period was 54° 7, being in precise agreement with the present year; the mean maximum was 62°, slightly lower than this year, and the mean minimum 47° 4, slightly higher than this year. These are the only Septembers in the last twenty-five years having such cold days at the commencement of the month. On 6 days of the first 10 days of September of this year, the mean daily temperature was below 55°, and on September 9 and 10 the maximum thermometer failed to touch 60°. Frost occurred in situations open to the sky on 3 nights. The coldest day was September 5, with a mean temperature 51°, which is 10° below the normal. The maximum temperature in the 10 days at Greenwich was 68° on September 1. It is not exceptional for the shade temperature to register 80° during the period, and in 1911, at the end of the abnormal summer, the thermometer on September 7 and 8 exceeded 90° at Greenwich, and in the 10 days there were 5 days with a temperature above 80°. In 1906 the shade temperature on September 1, 2, and 3 exceeded 90°.

THE experiment in agrarian colonisation in the Tripolis initiated by the Italian Government in the year 1922 forms the introductory article of the *Revista della Tripolitania*, an official publication dealing with matters relating to the Colony, of which the first issue has recently appeared. The contents are not confined to official matters, and if the promise of the first number is maintained, it should prove a source of information of value for which systematic provision hitherto had scarcely been adequate in view of its importance, especially from the archaeological and historical point of view. In the present number there are several articles of interest to archaeologists, including an account of the city of Leptis as a centre for the production of oil in Roman times, a well-illustrated account of archaeological remains, and a description of an interesting mosaic from what apparently was a small votive shrine set up in the fields by a Roman citizen. Prof. A. Ghigi publishes the first instalment of a survey of Libyan fauna. The remainder of the first issue is composed of articles of practical interest to agriculturists, such as the cultivation of the olive, industries subsidiary to agriculture, the raising of cattle and goats in Libya, etc., and reviews of recent books dealing with the country.

A PROJECT due to M. P. Gaudillau is described in the *Comptes rendus* of the Paris Academy of Sciences of July 6, which will take advantage of the difference of level between the Mediterranean and the Dead Sea. It is proposed to construct a canal with locks from Haiffa up to a pass at the head of the valley of Esdremon, where a tunnel two or three kilometres long will connect with another short canal leading down a valley to the head of the pipe line; the

latter will carry the water to the Jordan valley, running straight down the steep mountain-side, the available head being 343 metres. From the power-house in the valley the outflow will be in a canal, running with a moderate slope along the side of the range, down to the Dead Sea, where an additional fall of 120 metres to a second power-house can be obtained. The Mediterranean water will be pumped from reach to reach of the canal by means of electric pumps. It is proposed to store the fresh water of the Jordan, and use it for irrigation, and as the present average flow of the river is about 70 m.³ per second, and this amount of water is now disposed of annually by evaporation, it is considered that, by raising the level and so increasing the surface of the Dead Sea, it should be possible to dispose of an influx of salt water of 103 m.³ per second. To raise this water 80 metres to the head of the pass will require 190,500 horse-power, and 617,000 horse-power will then be available for conversion into electric energy, 426,000 of which, or 240,000 kilowatts, will be available for distribution in Palestine and Syria.

THE inaugural meeting of the forty-fifth session of the Junior Institution of Engineers will be held at the Society of Arts on Friday, December 11, when Mr. J. S. Highfield will be inducted president of the Institution by Dr. Alexander Russell and will deliver his presidential address.

MR F. W. H. MIGEOD, the well-known African traveller and authority on native languages, has consented to assume the leadership of the British Museum East African Expedition in succession to Mr. W. E. Cutler, whose death from malaria was announced at the beginning of September. Mr. Migeod will sail for Dar-es-Salaam by the next boat.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned. Senior entomologist, Ministry of Agriculture, Egypt—H E. The Under-Secretary of State, Ministry of Agriculture, Cairo (November 1) Chemical officer in the Medical Research Laboratory, Nairobi—Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (October 15)

Our Astronomical Column.

RECENT MODIFICATIONS IN THE THEORY OF STELLAR EVOLUTION.—Prof. H. N. Russell, who shared with Prof. Hertzsprung the honour of originating the giant and dwarf theory of the evolution of stars, is contributing a series of papers to the *Scientific American* (beginning in the September issue) on the changes of view that have taken place in the last year or two.

Prof. Eddington showed from statistics that when absolute magnitude and mass were correlated, giants and dwarfs lay on a single curve, in contradiction to the earlier view that an abrupt change took place at the point where the star became too dense to act as a gas.

The recent spectroscopic demonstration of the immensely high density of the companion of Sirius was a striking verification of Eddington's conclusion that the atom when stripped of its outer electrons is capable of enormous compression without ceasing to be a gas. This completely modifies the older conception of the falling temperature in dwarf stars. It now appears that the temperature in their interiors will continue to rise far into the dwarf stage. But a full consideration of the best manner of modifying the theory in view of the new facts is postponed.

OBSCURING COSMIC CLOUDS.—Father Hagen, of the Vatican Observatory, has during recent years published successive lists of what he describes as dark nebulae, covering considerable regions of the sky, in both low and high galactic latitudes. Prof. Öpik, of Tartu Observatory, concluded from a count of the faint stars on the Paris Astrogaphic Charts that these were produced by some obscuring medium.

As this would be a matter of supreme importance in all researches on distant objects, Prof. Harlow Shapley has made a fresh investigation, by taking long-exposure photographs with 24-inch or 16-inch refractors. These show stars nearly 3 magnitudes fainter than the limit (14.5 mag) of the Paris Charts. His conclusion (Harvard Coll. Ob. Circ. 278) is that the deficiency of stars in the regions in question does not extend to these fainter stars, as it would if obscuring clouds were the cause of it. In other words, the actual distribution of the stars brighter than 14.5 is much more irregular than the laws of chance distribution would suggest. Doubtless this is a manifestation on

a larger scale of the well-known tendency of stars in many regions to group themselves along regular curves.

The "obscure nebulae" of Father Hagen are concluded to be an effect produced on the eye by the great contrast in star density between the neighbouring regions. The star deficiency is real, but the appearance of a visible obscuring medium is illusory.

U.S. NAVAL OBSERVATORY ECLIPSE OBSERVATIONS, 1905-18.—The appendix to the Publications of the United States Naval Observatory, Second Series, Volume 10, Part 2, contains an account of the total solar eclipses of August 30, 1905, and June 8, 1918, with aviators' notes on the total solar eclipse of September 10, 1923. The first account opens with the general report of the 1905 Expedition by Rear-Admiral Colby M. Chester, who was Commander-in-Chief of the special line squadron of three vessels detailed by the Navy Department. Three principal stations were occupied not far from the shores of the Mediterranean, and each station was completely equipped for photographing the corona with long and short focus cameras, for spectroscopic and polariscope work, for meteorological observations, and for position observations. At none of the stations was there any interference from clouds, and the programmes in general were carried out as planned. The volume contains the individual reports of all the officers in charge of the various departments, and covers 335 pages. It is well illustrated by a large number of excellent plates.

The reports of the 1918 eclipse, occupying 51 pages, are next dealt with. This eclipse was observed at Baker, Oregon, but partial cloudiness was responsible for the meagreness of the observations. Practically no spectroscopic results were secured.

Unfortunately the weather conditions for the eclipse of 1923 were also unfavourable at all points occupied by the naval aviators. The programme included photographs of the corona and the moon's shadow on the earth. Partly from the weather conditions and partly from the inherent difficulties of making such observations from aeroplanes, the photographs are stated to have no scientific value.

Research Items.

INTELLECTUAL GROUPING OF MEN.—In a "Study of the United States Senate" Mr Arthur MacDonald, of Washington, D C, raises the question whether it is possible to arrive at any general principles concerning organisations of men, comparable to those already elaborated about animal organisations. He thinks that all organisations of men, especially those of long standing, act according to laws most of which are at present unknown. As a preliminary investigation, he subjects the transactions of a Senate of three sessions to a statistical examination. He studies the attendances of members during each of the three sessions, the attendances of the various political parties, of business as against professional members, the frequency of remarks for each political party, the previous life and education of the senators and their success. From these data he draws certain tentative conclusions, the most interesting of which are, that the professional men average much higher in the frequency of their remarks than the business men; that the professional men are in the majority, and that a large proportion were reared in the country, that the Democrats excel the Republicans in university education, that more than half of the legislation initiated in the Senate receives little or no attention. The method is suggestive, and a comparison with other countries would be of great interest. It would, however, be advisable, when presenting material of this kind, if instead of giving averages only some indication of their reliability were also presented.

VANISHING INDIAN TRIBES.—The urgent necessity of recording Indian languages and grammar, as well as the traditions and folk-tales of N America, before it is too late, is well illustrated in the introductory remarks which precede the study of Wiyot grammar and texts by Gladys A Reichard which has just been published as Pt 1 of Vol 22 of the University of California Publications in American Archaeology and Ethnology. In 1850 the peoples speaking the Wiyot language probably numbered about 1000. In historic times they occupied a territory of about 465 square miles on the shores of Humboldt Bay and the lower reaches of the Mud and Eel rivers in north-west California. In 1910, at the time of the census, their numbers had fallen to 58 full-blooded Wiyot, 13 partly of Wiyot and partly of other Indian blood, and 81 partly Wiyot and partly white, making a total of 152. Further, there were only 11 full-blood Wiyot under twenty years of age. In 1922, when the present investigation was made, there were not more than 100 persons living as Wiyot, of whom very few knew the language. Some lived in two small settlements on Humboldt Bay, the others were distributed in groups of a few families in various townships. It is noteworthy that where a Wiyot marries a member of another tribe, whether Athapascan or Yurok, the children speak the language other than Wiyot. Seven individuals were employed in furnishing and checking the material. It was found that the difference in individual pronunciation was so great as to be almost dialectal, which makes it particularly regrettable that more extended sources of information could not be obtained. A sketch of Wiyot culture was given by Kroeber in his Californian Handbook published in 1911.

THE AMOEBA OF DYSENTERY.—There have been many claims in the past of the successful cultivation of *Endamoeba histolytica*, the parasite of amoebic dysentery, most, if not all, of which have proved erroneous. Some new research has recently been pub-

lished (Proc Nat. Acad. of Sciences, U S A. Vol. 11, No 5, 1925, pp. 235 and 239). Boeck and Drbohlav have now succeeded by the use of a special culture medium. This consists of slants in test-tubes of beaten-up whole egg coagulated in an inspissator. The slant is covered with Locke's solution containing 1 per cent of crystallised egg albumin (human serum may also be employed). Inoculated into this medium, the amoebæ grow and multiply, feeding on bacteria and blood-corpuscles if these are added, and persist for five days, but are most numerous at the end of 48 hours. By sub-culturing within this period the cultivated amoebæ have been carried on for more than 90 generations. They maintained their virulence, and the ninety-third sub-culture, five months from the original culture, produced dysentery when inoculated into kittens. Chiang has been able to transmit the *E. histolytica* of human origin to rats, and the infection of rats is readily transmitted from rat to rat by association in the same cage. The results of this investigation incriminate the rat as a possible carrier of the amoeba of human dysentery.

SPECIFIC IMMUNITY OF TISSUES.—*Science* for July 31 (No. 1596) contains an address by Prof Elliott Prentiss on "Specific Immunity of the Tissues and its bearing on Treatment". He points out that every species of animal and plant has special preferences of habitat and food. This applies even to micro-organisms parasitic in the human body, many of which are localised in certain tissues (see also NATURE, February 16, 1924, Vol. 113, p 242). Thus, in tuberculosis the tubercle bacilli rarely infect the muscular tissues. Experiments were performed by injecting tuberculous animals and individuals with emulsions of muscle, and a certain amount of benefit resulted, suggesting that the tissues resistant to a particular infection might be employed in the treatment of that infection.

INSULIN TREATMENT.—In *The Fight against Disease* (the organ of the Research Defence Society) for July, an account is given of the records of some forty cases of diabetes treated at one of the London hospitals with insulin. Three of the cases died—one from hæmorrhage after an operation, one from cancer and pneumonia, and one from coma. The remaining 37 cases have done well and have been discharged from hospital to resume ordinary life. Faith in the value of insulin is therefore absolutely justified. The article is illustrated with a striking plate showing the condition of a patient before and after insulin treatment.

SWEDISH RAINFALL.—In Part II. of the Årsbok for 1924 of the Swedish Meteorological Service are published the full figures of rainfall observations for the year. For each of the stations, which number about a thousand, beside the total fall for each month of the year, there are given the fall on the wettest day of the month, and the total number of days on which rain and snow fell. Each month is illustrated by a map, and there is a map of the year's rainfall. Comparison with previous years shows that 1924 was almost everywhere in Sweden an unusually wet year, the average excess being 16 per cent. Only in a few parts of the extreme south of the country was there a slight deficiency, which nowhere exceeded 10 per cent.

ECHO SOUNDING.—An important article on this subject appears in the *Hydrographic Review* for May 1925, the semi-annual publication of the International Hydrographic Bureau. The article is intended to

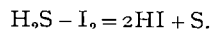
complete the information on this subject given in earlier issues of the *Review* (December 1923 and October 1924), and, while it contains little that is actually new, it collects certain scattered information from various sources in different countries. Descriptions are given of various forms of apparatus, including the sonic depth-finder of the American navy and Behm's apparatus, with a report of trials carried out with the latter by the Danish navy. The article concludes with a bibliography of the subject from 1912 to the present year. The contents of this article comprise Special Publication No. 4 of the Hydrographic Bureau.

TIDE PREDICTION—The annual report of the Tidal Institute of the University of Liverpool, just issued, describes the work of the Institute during 1924, the sixth year of its activity. On the more routine side, its work has included analyses of tidal observations made at Liverpool (4 years) and at Portland (1 year), the latter being done for the Admiralty; at Ystad, on the Baltic (4 years' observations), for the International Hydrographic Bureau at Monaco; and at Portage Island, Canada, for the Canadian Tidal Survey. Tidal predictions of the times and heights of high and low water during 1926 have been prepared for Liverpool, Portland, and seven ports in New Zealand and Australia; these predictions, made for or through the Admiralty, have been executed on the new machine presented to the Institute last year, and installed at the Bidston Observatory. The machine, which is of the Kelvin type, and made by Lord Kelvin's firm, is described and illustrated in the report, more harmonic constituents can be dealt with than by previous instruments of a similar kind, and various useful improvements are incorporated in the design. In addition to the development of methods of analysis and prediction, with special reference to this machine, various theoretical dynamical researches on tides have been published or continued during the year. The financial expenses of the Institute have been met partly by its earnings for commissions executed on behalf of other institutions, but mainly by the Liverpool Steamship Owners' Association.

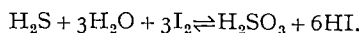
WELSH SLATE—The Welsh slate-quarries, employing more than eight thousand men, produce the finest slates in the world, and furnish more than 80 per cent. of the total output in the British Isles. The National Museum of Wales has therefore done well to issue a small hand-book on "The Slates of Wales," written by Dr. F. J. North, Keeper of Geology in the Museum. It is a pamphlet of 66 pages, liberally illustrated, and presents an interesting subject in language intelligible to the general public. There is a general part, dealing with the nature and origin of slate and the manner in which it has acquired its peculiar fissile structure. The author might have brought out more clearly the fact that in the better-class slates practically the whole of the material has been reconstituted *in situ*, before and during the impression of the cleavage-structure. The more special part of the work includes an account of the distribution of workable slates in the Cambrian, Ordovician, and Silurian formations of Wales, some description of the getting of slate and the manner of preparing it for the market, and an interesting history of the Welsh slate industry, which dates from the latter part of the eighteenth century. There is also a good classified bibliography of the subject. This little book, published by the Museum at Cardiff at the price of sixpence, is admirably suited to engage the interest of the intelligent visitor, and to kindle a desire for fuller knowledge.

THE CONTINUOUS SPECTRUM OF HYDROGEN.—The continuous spectrum of gases is of great theoretical importance from the astrophysical point of view, as explaining the continuous spectra emitted by the sun and by stars. Messrs. H. Schuler and K. L. Wolf describe, in the *Zeitschrift für Physik*, July 18, a series of observations of the continuous spectrum of hydrogen, from which they conclude that it is due to the reunion of dissociated atoms to form molecules, and they express the opinion that this is also the case with other gases the molecules of which consist of more than one atom, including the halogens, for the continuous spectrum of which Steubing has recently given another explanation. Experiments show that the continuous spectrum of hydrogen, which reaches from about $4800 \text{ \AA}$ U to $2100 \text{ \AA}$ U, is not related in intensity to the Balmer series, or to the many line spectrum of the gas. The long wave-length boundary of the continuous spectrum agrees satisfactorily with that calculated from the heat of dissociation, which confirms the authors' view as to the origin of the spectrum. It is found that the intensity of the spectrum is strongly affected by the electric field, with which it increases, and it is suggested that reunion of atoms to form molecules is facilitated in an electric field. An experiment in which a very intense continuous hydrogen spectrum, with very few hydrogen lines, was produced in calcium vapour to which a little hydrogen was added, is considered to support the above view. Franck and Cario have shown that molecular hydrogen is dissociated by means of energy derived from excited mercury atoms, and it is thought probable that calcium atoms act in the same way, and that it is the reunion of these dissociated hydrogen atoms which causes the continuous spectrum in the last-mentioned experiment.

WATER IN CHEMICAL ACTION—A series of papers on the influence of water on certain chemical reactions, by L. B. Parsons, is published in the July issue of the *Journal of the American Chemical Society*. Solid potassium iodide and bromide both react immediately with moist chlorine, whereas no appreciable action occurs if the chlorine is dry. It is shown that a minimum partial pressure of water vapour, approximately equal to the vapour pressure of a saturated solution of the components present during the reaction, must be reached before reaction can take place. The reaction between hydrogen sulphide and iodine in ether solution runs to completion in the absence of water.



In the presence of water the reaction is incomplete:



The equilibrium point depends on the relative concentration of the water, diffused daylight has no appreciable effect. Atmospheric oxygen must be excluded from the system, however, as it oxidises ether to ether peroxide (Clover, 1922), thus changing the nature of the whole reaction. Many observations have been recorded of the ability of water to produce combination between various metals and iodine. It is now shown, however, that this property is not peculiar to water, but is possessed by many organic liquids. A close parallelism exists between the ability of a liquid to bring about reaction between a metal and iodine and the solubility of the metallic iodide in the liquid. Apparently the function of the liquid consists in removing the film of solid iodide from the metal surface. These researches are of importance in view of the large number of varied cases known in which water acts as a catalyst.

The Russian Academy of Sciences.

A MEETING was held at the London Central Y.M.C.A. on Thursday, September 10, in connexion with the bicentenary of the Russian Academy of Sciences, the celebration of which, at Leningrad and Moscow, has just been concluded. The meeting was arranged on the initiative of the Science Section of the Society for Cultural Relations (S.C.R.) between the peoples of the British Commonwealth and the Union of Socialist Soviet Republics (U.S.S.R.). Sir Richard Gregory, who occupied the chair, pointed out that the sole intention of the assembly was to send a message of appreciation and encouragement to scientific workers in Russia. For two centuries the torch of learning had been kept burning by the Academy of Sciences, and though at times it had flickered, it had never been extinguished since it was lit. One of the objects of the S.C.R. was "To take any action deemed desirable to forward the intellectual and technical progress of both peoples"; and the meeting could therefore appropriately associate itself with representatives of science who had gone to Russia to take official part in the celebration of the bicentenary of the Academy. Sir Richard Gregory referred appreciatively to Belopolsky's brilliant spectroscopic work at the Pulkova Observatory, and said that a forty-one inch object-glass was now being ground at the works of Sir Charles Parsons in Newcastle, for use in the largest refracting telescope in the world, to be erected in Russia.

Prof. A. N. Kriloff, a member of the Academy, gave some particulars of its establishment and early activities. He pointed out that two hundred years ago Russia differed very much from other European countries and was described as a purely Asiatic State. On the vast territory where now 150 millions have plenty of room to live, only eight millions were distributed. Almost all the inhabitants were illiterate, no schools existing except some in monasteries for the education of the clergy. Up to the time of Peter the Great, the only books were the Bible and books for church service, which were written in the old Slavonic language. When Peter the Great founded the Academy of Sciences, after having assisted at a meeting of the French Academy in Paris during one of his voyages, he invited the celebrated Leibnitz to prepare the statutes, and signed at the end of his reign an "ukase" promulgating the foundation of the Academy, but his death occurred before the work of the new institution began. Thus in a country with one single lay school created some twenty years before by Peter—the "Navigation School," which was managed by the Englishman Farquarson—an Academy of Sciences was established. It seems that such an enterprise had no sound basis, as not only "science" did not exist in the country, but the language had no actual word for it. The founders had the wisdom, however, to invite as the first members of the Academy not learned men and teachers of sciences only, but "creators" of the science, such as the two brothers Bernoulli and Euler. Euler was for fifty-seven years a member of the Russian Academy, and his far-reaching mathematical discoveries and works filled more than one half of the first hundred volumes of the proceedings of the Academy. During the first forty years of its existence, the Academy was not only a scientific body but also a school of education. The Russian members had to carry out research work in natural science and also to elaborate the Russian literary and scientific language, trying to approach the half Slavonic language

of the books to the spoken language of the people. The need to organise the language, and to establish a system, was so acute that some fifty years later a special Academy for Russian Language and Literature was created. This Academy had a special name—the Russian Academy—but in 1818 the new institution was joined to the Academy of Sciences to form one of its Sections, and the Academy of Sciences entered upon its second century with three sections, namely: (1) Physico-mathematics, (2) Russian Language and Literature, and (3) History and Philology.

"At the beginning of its second century," continued Prof. Kriloff, "we see the Academy to be a purely scientific institution of world renown, in a country with a definite system of education from primary schools to universities, with a well-developed literature, an elaborate scientific language, and scientists of Russian origin in different branches of sciences. The work of the Academy proceeds quietly like the work of analogous foreign institutions, and a great deal of it is devoted, as in the beginning, to the study of the vast territory of Russia and of its natural resources. In its third century the Academy enters at a time when the country and the people, having gone through a war and a revolution, have re-created the government and are re-creating life itself on a new foundation, but now the Academy stands on a solid ground and directs with certainty its researches and work to the benefit of the people and of the country. The Academy numbers forty-one fellows and has several scientific institutions under its direction, a library with four and a half millions of volumes, and an archive. In addition to biological institutions, other institutions are: the physico-mathematical one, with a new Röntgen-ray equipment, and the seismological survey. The mechanical works attached to this institution are able to supply instruments for international geophysical and geodetic research. At the chemical laboratory a new section of organic chemistry was created in 1923; and a Radiological Institute was organised in 1922. The well-known Pulkova Astronomical Observatory is extending its activity to the south of Russia and will begin observations with new first-class instruments supplied this year from England. Seven Museums belong to the Academy, namely: the Geological, Botanical, Zoological, the Pushkin House, the Historical and Bibliographical Museum, the Museum of Ethnology and Anthropology, and the Asiatic Museum."

Prof. P. I. Schmidt, curator of the Zoological Museum of the Russian Academy, gave an account of the organisation of regional survey work which has recently been instituted in the Republics. In the course of his address he said: Science is universal, and being the highest achievement of mankind, is its most valuable treasure. From this point of view, science is certainly international. But there is a kind of scientific research which is of special value for a definite country, such as the branches which study the nature of a country, its flora and fauna, the history and the life of its population. To rule a country and to guide it to prosperity and economic well-being, it is absolutely necessary to know the natural resources of the country, its geographical and climatological conditions, as well as the character and abilities of its population. Research of this kind is of a special value in Russia with its numerous regions differing widely in climate and population. During the past two centuries the

Academy of Sciences has played the first and chief part in the investigations of the natural resources of Russia and in the history and the study of the present conditions of its population. The small towns of Russia were never deficient in people interested in natural science, archæology, history, ethnography. These people steadily accumulated an extensive knowledge of the different regions they inhabited. Small societies, local museums, archives, biological stations have existed for some considerable time. But they could not before the Revolution unite their forces for the purpose of collaboration. Now, on the contrary, the separate organisations are freely able to get into touch with one another.

The first call for the organisation of regional survey came from the Academy in 1921, when an All Russian Congress of the Societies for Regional Survey was brought together in Moscow. In January 1922 a Central Bureau of Regional Survey was organised at the Academy of Sciences, Leningrad, with a branch in Moscow. This Bureau collected information about already existing institutions for regional survey, brought them into connexion with each other, and supplied them with every kind of help. The Bureau also started a periodical, *Regional Survey*, and published monographs and text-books on this subject. In March 1923, some 231 societies, their branches and associated clubs, were on the list, with 285 museums, 21 biological stations, and 16 natural reserves or parks. But a good many more societies have been started since, and up to last June the number of institutions dealing with regional survey was more than 1000. A map of Russia, on which these societies are marked, represents a dense conglomeration of points.

Many of the regional survey organisations have developed out of the former scientific societies, such as those in Vologda, Kostroma, Saratoff, Tamboff, and other cities. Those societies had already recorded observation after long periods, and at present they have only enlarged their programmes and increased their activities. A great many new societies of regional survey have also been created in small towns and villages.

Museums represent the simplest and easiest way for the popularisation of scientific knowledge, and are therefore largely used for educational purposes. But members of the societies do not restrict their work to such purposes. They do their best to do some scientific research as well. They organise meteorological and biological stations, and arrange excursions and scientific expeditions on a small scale in order to study the local conditions, ethnographical, statistical, and economic research is also undertaken by them. Many of the regional survey societies pay especial attention to the history and archæology of the country, they collect antiquities and study the history of the region. Most of the societies start the publication of the results in their own separate papers, and such periodicals are often of great value and interest. Some societies publish descriptions of their regions, for example, the regional survey society in a small town Usman, of the Voronej province, has published a map of this district on the scale of 4 kilometres to an inch, with a fairly good description of the Usman district.

The following resolution was then moved by Sir Arthur Smith Woodward: "That this meeting of members and friends of the Society for Cultural Relations between the Peoples of the British Commonwealth and the Union of Socialist Soviet Republics sends cordial greetings and congratulations to scientific workers in the U.S.S.R. on the celebration

of the bicentenary of the Russian Academy of Sciences, and in high appreciation of the great work by which the Academy has enriched the knowledge and culture of the world during the past two centuries, looks with confidence to the future for further contributions to promote the intellectual unity of mankind."

Sir Arthur Smith Woodward, in proposing the resolution, said he did so with special pleasure because he was an honorary member of the Russian Academy, and had profited much by the researches of some of the academicians and other Russian men of science. He had visited the seat of the Academy on three occasions under the old conditions in 1889, 1892, and 1903, and had learned to appreciate the facilities it afforded for scientific work. He made his home with Dr. Friedrich Schmidt, in whose rooms he met most of the active naturalists of St. Petersburg, as it was then termed. Dr. Schmidt himself was the leading authority on the rocks and fossils of the Silurian System, and was still more widely known by his investigation of the deposits in which the carcasses of the mammoth occurred in Siberia. Inostransev, professor of geology in the university, was busy with Russian stratigraphy and petrology, and trained several brilliant students. Lahusen, of the School of Mines, produced the first Russian text-book of palæontology on modern lines. Yakovlev and Tolmachev were also beginning their valuable researches on palæozoic geology. Baron von Toll was studying the collections he had made in the New Siberian Islands, where he eventually lost his life. In 1903 Salensky had just mounted the unique mammoth from Bereskovka in the Zoological Museum, and had completed the first memoir on it. Amalitzky was at work in Warsaw on the great collection of Permian reptiles which he had made on the Northern Dwina—one of the most important achievements in palæontology. Karpinsky was directing the Geological Survey of Russia, and publishing fundamental contributions to geology. He must be ranked among the foremost geologists of Europe, and, though now in his eightieth year, still retains all his enthusiasm as the honoured president of the Academy. Dr. Karpinsky is highly esteemed in England, and received the Wollaston Medal from the Geological Society of London in 1916.

Dr. T. R. Parsons, in seconding the resolution, referred to the physiological work of Pavlov and others which he had opportunities of seeing during a visit to Leningrad and Moscow a few months ago. The resolution was then put to the meeting and carried unanimously.

Cordial messages of support of the motion were received from the following among others: Prof. A. E. Boycott, Mr. Victor Branford, chairman of the Sociological Society, Sir Frank Dyson, Prof. A. S. Eddington, Prof. J. J. Findlay, Prof. J. W. Gregory, Prof. G. H. Hardy, Prof. L. T. Hobhouse, Prof. J. S. Huxley, Prof. J. N. Langley, Prof. A. D. Lindsay, Master of Balliol, Prof. C. J. Martin, Hon. Bertrand Russell, Prof. J. Y. Simpson, Prof. E. Soddy, Sir Gilbert Walker, Mr. H. G. Wells.

The Literature of Radioactivity.¹

THE report before us of the Committee on X-Rays and Radioactivity of the National Research Council of the United States consists of a review of radioactivity and its problems as discussed in recent

¹ Bulletin of the National Research Council. Vol. 10, Part 1, No. 51: Radioactivity. Report of Committee on X-Rays and Radioactivity, National Research Council. By A. F. Kovarik and L. W. McKeehan. Pp. 203. (Washington, D.C.: National Academy of Sciences, 1925) 2.25 dollars.

years. It is essentially a bibliography, not a developed account of the present state of knowledge in this subject.

The authors have taken as their starting point the year 1916, for in that year was published the well-known book of Meyer and von Schweidler, which contains an almost complete list of references to the earlier papers in radioactivity. The whole of the literature of radioactivity from that year until June 30, 1924, has been searched and the results recorded in this report. The limits of time have been overstepped in a few particular cases where earlier papers had been overlooked in previous works or where later papers were of special interest. Between the given limits the literature has been covered with remarkable thoroughness and very few, if any, papers have been missed. One result of this thoroughness is that many papers of doubtful interest or value are included, and that criticism and comment are reduced to a minimum. In general, the results and conclusions of an author are stated briefly and, unless the matter is of wide interest or of prime importance, comment is withheld.

The literature has been divided into seven main sections, under the following headings: the radioactive transformations, the α -, the β -, and the γ -rays, nuclear structure and radioactive processes, radioactivity in geology and cosmology, and the effects of the radiations upon matter. A concise account of each subject as it arises is given, and this is followed by reports on the papers published on the subject. A most valuable feature of the book is the collection of tables at the end of each chapter. In particular, we might mention the table of β -ray spectra and the table of γ -ray spectra deduced from β -ray spectra. One error must be pointed out. In the tables of p. 68 and p. 70, α -particles of range 3.8 cm are attributed to radium C, on the authority of Bates and Rogers. These α -particles have never been detected. Their presence is inferred from a knowledge of the transformations, and their range has been calculated from the period of radium C, using the Geiger-Nuttall relation.

A point which may give rise to some discussion is an attempt of the authors to introduce a systematised nomenclature of the radioactive substances. The symbol they propose consists of the atomic number of the element, followed first by the chemical symbol of the principal member of its series, and then by a Roman numeral indicating the genetic order of the radio-elements, for which the first two parts of the symbol are the same. Thus the proposed symbol for uranium 1 is 92 UI; uranium X₁ will be 90 UI, and uranium 2 will be 92 UII, and so on. This system is simple and rational, and has many and obvious advantages over the names and symbols in general use. But the latter, however arbitrary they may appear, were born out of the irregular and adventurous history of the subject of radioactivity and will not lightly be put aside for any system, rational though it be.

The report contains references to about 1500 papers, nearly all of which have been published in the brief space of eight and a half years, that is, at the rate of 15 per month. These figures show the need for a bibliography such as this, and also indicate the magnitude of the task undertaken by the authors. They are to be congratulated on carrying out their arduous and difficult work in a most thorough way. The result of their labours is a book which should save a great deal of time and trouble to workers in radioactivity.

J. C.

University and Educational Intelligence.

CAMBRIDGE.—The E. G. Fearnside Scholarship for research in the organic diseases of the nervous system has been awarded to Dr. T. K. MacLachlan, Pembroke College.

A STATISTICAL report on the universities of Canada for the year ended June 1924 has been published by the Dominion Bureau of Statistics. It gives a total of 18,026 regular students excluding those in preparatory (pre-matriculation) classes. Students of medicine numbered 2911, engineering and applied science 1949, theology 951, commerce 859, education 818, music 791, law 541, agriculture 526, household science 511. There was a very noticeable increase in the number of students pursuing "short courses," including courses organised in co-operation with the Workers' Educational Association, summer schools, and short courses in agriculture, journalism, "business," nursing, and other vocational subjects. Most of these courses were provided by the universities of Toronto, McGill, Manitoba, British Columbia, and Saskatchewan. 1862 students followed correspondence courses, provided chiefly by Queen's University, Ontario, and the universities of Toronto and Montreal. The current expenditure of all the universities amounted to nearly 1,800,000, the largest spenders being Toronto and McGill, nearly 400,000 each, Alberta 206,000, Saskatchewan 117,000, Manitoba 114,000, British Columbia 110,000, Queen's 100,000. The report directs attention to the fact that in some cases denominational universities (in the province of Quebec) are subsidised by the government. Of the total income rather less than one-fifth was in the form of fees, one-sixth was from investments, and one-half from government grants.

A SURVEY of engineering education in the land-grant colleges in the United States is given in Bulletin (1925) No. 5 of the Bureau of Education. The following important changes, among others, have taken place since 1910. Nearly all of the colleges have eliminated foreign languages from the curriculum or made them elective instead of compulsory. On the other hand, greater attention is given to English and to economics and business administration, required or elective courses being included to an increasing extent in such subjects as corporate organisation and finance, business law, patent law, accounting and cost keeping, banking, and salesmanship. Courses in highway and automobile engineering have been added to the curricula in many institutions. There has been a marked tendency towards postponing specialisation, the first year, or even the first two years, being made common to all branches, and more attention being given to thorough training in fundamental subjects. Much attention has been given to the orientation of freshmen. Shop practice instruction has changed in character, the general tendency being toward the conversion of the college shops into shop laboratories for illustrating modern methods of shop production, and of factory organisation and management, rather than for the acquisition of manual skill such as is required in mechanics. There has been some extension of the "sandwich" or co-operative system, especially in electrical and chemical engineering, under which the student spends half his time in the university and half in some industrial plant. In the United States this practice was first developed systematically by the University of Cincinnati.

Societies and Academies.

CAPE TOWN.

Royal Society of South Africa, July 15.—A. J. Hesse: Note on South African Rhyncophora. There are 270 species of the polymorphic genus *Brachycerus* in South Africa. Their chief enemies are secretary birds, bustards, and avicularid spiders. The eggs, which are rarely found, are deposited two or three at a time. Some larvæ are used as food by natives. Certain larval secretions form a native remedy for toothache. The adult insects are used by the Zulus as pendants for necklaces. Gradation of characters from species to species exists in certain groups.—F. G. Cawston: The molluscan hosts of South African Trematoda. Cercariæ have been isolated from at least eighteen species of fresh-water mollusca in South Africa, including the three genera of Ancyliidæ.—R. F. Lawrence: Note on the Arachnida of South-West Africa. The relation of the Pseudoscorpions to the other groups of Arachnida was touched upon and, in illustration, a new species of *Garypus* from Sesfontein, South-West Africa, was exhibited. This species is exceptionally large, measuring 7 mm in length, and is found under thin layers of weathering limestone. A new species of binocular spider, *Diploglena*, closely related to the genus *Nops*, which only occurs on the islands off the mainland of Brazil and Venezuela, is a striking example of the degeneration of the eyes owing to disuse in spiders living under stones.

PARIS.

Academy of Sciences, August 3.—Charles Nicolle and E. Conseil: The production of an experimental preventative serum for exanthematic typhus. Stages and solution of the problem. The serum obtainable from the ass, after experimental inoculation with the disease, has preventative properties, although the serum is not so rich in antibodies as the serum from human subjects recovering from the disease.—Maurice Fréchet: The law of errors of observation.—R. H. Gernay: The asymptotic solutions of the equations which define implicit functions, and on the asymptotic integrals of partial differential equations.—G. W. Ritchey: A new method of construction of large telescope mirrors.—V. Nechvile: Determination of the proper motions of stars from the 5th to the 16th magnitude, photographed on the first negatives of Henry.—Y. Rocard: The diffusion of light in fluids. A comparison of the formulæ obtained by Vessiot-King, Ramanathan, and Gans.—M. Auméras: The state of hydration of calcium oxalate. Under the conditions of the experiments described the salt had the composition $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$.—René Girard: The action of dilute solutions of acids on the ferrous metals.—V. Thomas: A new type of organo-magnesium compound. Starting with di-iodobenzene and magnesium, in addition to the formation of $\text{C}_6\text{H}_4\text{I MgI}$, there is evidence that some $\text{C}_6\text{H}_4(\text{MgI})_2$ is produced.—N. Arabu: Stratigraphic remarks on the fault of Ribeaupvillé (Haut-Rhin), to the north of Strengbach.—L. Jaloustre, G. Danne, M. Dementitroux, and A. Maubert: The radioactivity of the waters of Contrexéville (Vosges) the Pavilion and Quai springs. The water from the Pavilion spring contains 0.85 millimicrocurie of emanation and not exceeding 0.5 millimicrogram of radium per litre. The Quai spring contains 2.5 millimicrocuries of emanation and 0.33 millimicrogram of radium per litre.—Dedebant: The isolation of the dynamic tendencies in regions with a large daily variation of pressure.—Louis Emberger: The chondriome in plants.—Emile André and Franck Guichard: Contribution to the study of the fats from

American palms. Murumuru butter. Details of the usual physical and chemical constants are given for this fat, together with the results of methanolysis followed by fractional distillation of the methyl esters.—E. Ivanoff: A new mode of conservation and transmission of trypanosomes and spirochaetes in the larvæ of *Galleria melonella*. The larvæ of *G. melonella* can be utilised for assuring the continuity of cultures of trypanosomes in the laboratory, and for despatching them on a journey lasting several days.

WASHINGTON, D. C.

National Academy of Sciences (Proc. Vol. 11, No. 7, July).—Cornelia G. Benedict, Francis G. Benedict, and Eugene F. Du Bois: Human metabolism in an environment of heated air. Observations were made on five subjects (3 men and 2 women) placed in an air-tight bag through which a stream of heated, dry air (about 85°C) was passed. Loss of weight was 5 to 13 times greater than normal, oxygen consumption increased slightly, while skin temperature was fairly uniform and only one degree or so above normal owing to the cooling effect of perspiration.—Herbert M. Evans: Invariable occurrence of male sterility with dietaries lacking fat soluble vitamin E. Progressive loss of sexual powers and interest occurs in male rats, but it can be prevented by feeding, from date of weaning, single natural foods which cure the corresponding female sterility. Male sterility is often cured by protracted administration of vitamin E in ether extract of wheat germ.—Karl E. Mason: A histological study of sterility in the albino rat due to a dietary deficiency. Progressive stages of degeneration of the testes were obtained. Feeding with lettuce, provided some normal seminiferous tubules remain, checks degeneration, or, if fed before it sets in, prevents it.—Walter S. Adams: The relativity displacement of the spectral lines in the companion of Sirius (*v. NATURE*, August 22, p. 285).—W. M. Davis: The basin range problem. A recent visit to the Great Basin region, which includes all Nevada and parts of Utah, Arizona, California, and Oregon, provided examples confirming Gilbert's fault-block theory of the origin of many of the ranges.—James Kendall and Beverly L. Clarke: The separation of rare earths by the ionic migration method. An agar-agar gel containing a mixture of salts of two rare earth metals is placed in a wide tube between similar gels containing a faster cation (near the cathode) and a slower cation (near the anode). On electrolysis, the two boundaries remain sharply defined, but great care is needed in preparing the gels. The cations of the rare earth mixture should have different ionic mobilities leading to their accumulation at the ends of rare earth gel section. After runs of about twenty days with a current of 0.6-0.8 amp. at 240 volts, during which the rare earth section was moved up to 400 cm., separation of an yttrium-erbium mixture was effected (99.1 per cent. yttrium) and considerable separation of neodymium-praseodymium and gadolinium-samarium mixtures.—R. H. Fowler and E. A. Milne: A note on the principle of detailed balancing. The principle of entire equilibrium announced by Prof. G. N. Lewis has been exploited extensively in physics in recent years under the name (among others) of "the principle of detailed balancing."—W. H. Rodebush and E. F. Fiock: The measurement of the absolute charge on the earth's surface. Copper quadrants are mounted on insulators just above the ground and earthed through a ballistic galvanometer. Rotating quadrants directly earthed can be superimposed, making the former quadrants virtually the

inside of a conductor. The results indicate that the ground is negatively charged (10^{-10} coulombs per square metre); day and night (or solar eclipse) cause little change, but at the beginning of a rain-storm the charge drops to zero and may become slightly positive.—Edward W. Berry: Fossil plants from the tertiary of Patagonia and their significance. A collection from Mirhoja, Chubut Territory, contains determinable forms which are American and show no traces of African relationships. The age of the deposit is Miocene, and all except one specimen, a grass, are dicotyledonous arborescent forms or lianas. They indicate a genial climate with abundant rain for the period.—Laurence H. Snyder: Human blood groups and their bearing on racial relationships.—Carl Barus: Inductance treated acoustically by differential telephones.—Albert Björkeson: X-ray radiation from hot sparks. The X-rays originate chiefly at the solid electrodes.—Edwin H. Hall: The four transverse effects and their relations in certain metals. Knowing the electromagnetic coefficients (Hall and Ettingshausen effects) enables qualitative calculations to be made of the thermomagnetic coefficients (Nernst and Leduc effects).—Gilbert N. Lewis: The distribution of energy in thermal radiation and the law of entire equilibrium. Anticipations of this law have been less general than is now claimed. Its application to radiant energy is a crucial test. It leads to an equation of the form of the Wien distribution equation, which is contradicted by experiment. The Wien equation really applies to an "ideal" radiation analogous to an "ideal" gas.—Leonard B. Loeb: Ionic mobilities in ether as a function of pressure. As in permanent gases, the newly formed ions have about the same mobilities, but that of the positive ion decreases in about 0.03 sec., due apparently to a change in the diameter of the ion with age.—Richard C. Tolman: The principle of microscopic reversibility. Lewis's "law of entire equilibrium" has been stated before under the name of "the principle of microscopic reversibility." It is regarded as "an unproved assumption."—John P. Minton: The dynamical function of the tympanic membrane and its associated ossicles. Two modes of action are suggested: at low frequencies, the drum vibrates as a piston and the ossicles act as multiplying levers setting up relatively large pressure changes acting on the oval window; at high frequencies, they conduct flexural vibrations of the drum to the oval window. This explains middle-ear deafness to low frequency sounds and other effects.—Linus Pauling and Albert Björkeson: A new crystal for wave-length measurements of soft X-rays. The plane 00.1 of the hexagonal crystal β -alumina (Al_2O_3) gives very strong first and second order reflections. It has the unusually large grating constant of $11.2 \text{ \AA}$ and should be valuable for wave-length determinations with soft X-rays.—J. Hadamard: (1) On quasi-analytic functions. (2) The approximate evaluation of definite integrals. A better value is obtained by combining Simpson's value with the Euler-Maclaurin correcting terms.

Official Publications Received.

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 8: Elementary Instruction of Adults. Report of the National Illiteracy Conference Committee. Pp. v+33. 5 cents. Bulletin, 1925, No. 10: The Rural High School; its Organization and Curriculum. By Prof. Emory N. Ferriss. Pp. vi+74. 10 cents. Bulletin, 1925, No. 4: Land-Grant College Education, 1910-1920. Part 3: Agriculture. Edited by Walton C. John. Pp. v+108+8 plates. 25 cents. Bulletin, 1925, No. 5: Land-Grant College Education, 1910-1920. Part 4: Engineering and Mechanic Arts. Edited by Walton C. John. Pp. v+75+7 plates. 20 cents. (Washington: Government Printing Office)

The Physical Society of London. Proceedings. Vol. 37, Part 5, August 15. Pp. xix+266-355. (London: Fleetway Press, Ltd.) 6s. net. Technical College, Bradford. Diploma and Special Day Courses, Session 1925-26. Pp. 192+26 plates. (Bradford)

Year Book of the Michigan College of Mines, 1924-1925, Houghton, Michigan. Announcement of Courses, 1925-1926. Pp. 121. (Houghton, Mich.)

Ministry of Agriculture and Fisheries. First Progress Report of the Foot-and-Mouth Disease Research Committee. Pp. 43. (London: H.M. Stationery Office) 1s. 3d. net.

British Museum (Natural History). Precious Stones. Series No. 1, Set D3. 6 cards in colour. Series No. 2, Set D4. 5 cards in colour. Series No. 3, Set D6. 5 cards in colour. Series No. 4, Set D6. 5 cards in colour. British Flowering Plants. Series No. 7, Set F10. 5 cards in colour. Series No. 8, Set F11. 5 cards in colour. (London: British Museum (Natural History)) 1s. each set.

Journal of the Indian Institute of Science. Vol. 8A, Part 1: The Photochemical Oxidation of Aromatic Hydrocarbons. I. By J. J. Sudborough, H. E. Watson and B. T. Narayanan. Pp. 7. 8 annas. Vol. 8A, Part 2: Kachu-Grass Oil. By Bijoor Sanjiva Rao and J. J. Sudborough. Pp. 9-27. 1 rupee. Vol. 8A, Part 3: Argemone Oil. By S. Narayana Iyer, J. J. Sudborough and P. Ramaswami Ayyar. Pp. 29-33. 12 annas. Vol. 8A, Part 4: Essential Oil of *Cyperus rotundus*. By B. Sanjiva Rao, P. B. Panicker and J. J. Sudborough. Pp. 39-47. 8 annas. Vol. 8A, Part 5: Dehydration of Rectified Spirit by means of Anhydrous Calcium Chloride. By J. J. Sudborough and P. Ramaswami Ayyar. Pp. 49-54. 8 annas. Vol. 8A, Part 6: The Hydrolysis of the Amides of $\alpha\beta$ -Unsaturated Acids and of their Saturated Analogues. By A. R. Yathiraja and J. J. Sudborough. Pp. 55-69. 1 rupee. Vol. 8A, Part 7: (1) Studies relating to the Acetone-producing Organisms, by Gilbert J. Fowler and V. Subramanyan; (2) Mahua Flowers as Raw Material for the Acetone-fermentation Process, by A. G. Gokhale. Pp. 71-87. 1 rupee. Vol. 8A, Part 8: Studies in Esterification. By B. V. Bhide and J. J. Sudborough. Pp. 89-127. 1.8 rupees. Vol. 8A, Part 9: Constituents of the Marking Nut, *Semecarpus anacardium*, Linn. By D. Satyanarayana Naidu. Pp. 129-141. 8 annas. Vol. 8A, Part 10: Notes on some Indian Essential Oils. By Bijoor Sanjiva Rao, J. J. Sudborough and H. E. Watson. Pp. 143-188. 2 rupees. Vol. 8A, Part 11: Bromo-Derivatives of Para-methoxycinnamic Acid. By K. V. Harinaran and J. J. Sudborough. Pp. 189-210. 1.8 rupees. (Bangalore)

Nyasaland Protectorate: Geological Survey Department. The Physiography of the Shire Valley, Nyasaland, and its Relation to Soils, Water Supply and Transport Routes. By Dr. F. Dixey. Pp. 22. (Zomba.)

Annual Report of the Executive Council of the National Institute for the Blind for the Year ended March 31st, 1925. Pp. 78+15 plates. (London: 224-8 Great Portland Street.)

Navy (Health). Statistical Report of the Health of the Navy for the Year 1925. Pp. v+170. (London: H.M. Stationery Office) 6s. net.

Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C. Syllabus of Classes, Session 1925-1926. Pp. 113. (London.)

Department of Agriculture, Trinidad and Tobago. Administration Report of the Director of Agriculture for the Year 1924. (Council Paper No. 52 of 1925.) Pp. 26. (Trinidad) 1s.

Battersea Polytechnic, Battersea Park Road, London, S.W.11. Calendar of Evening and Afternoon Classes for Session 1925-1926. Pp. 23. Free. Technical College for Day Students, and Day School of Art and Crafts. Calendar, Session 1925-1926. Pp. 43+10 plates. 3d. Domestic Science Training College. Session 1925-1926. Pp. 23. 6d. Department of Hygiene and Public Health. Pp. 26+4 plates. 3d. (London.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 36, Part 2, August 21st. Pp. 107-202. (London: Edward Stanford, Ltd.) 5s.

The Hundred and Third Report of the Commissioners of Crown Lands, dated 30th June 1925. Pp. 36. (London: H.M. Stationery Office.) 3s. net.

The North of Scotland College of Agriculture. Calendar, Session 1925-1926. Pp. viii+120. (Aberdeen.)

Diary of Societies.

TUESDAY, SEPTEMBER 22.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—Oliver G. Pike: Birdland Cameos.

FRIDAY, SEPTEMBER 25.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—J. Vary Lyle: From Domesday to the "Scrap of Paper." (A look round H.M. Public Record Office.)

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (Conference at Balliol College, Oxford), at 8.45.—Dr. R. S. Hutton: The Present Position with regard to the Association of Special Libraries and Information Bureaux.—A. E. Twentyman: The Classification of a Specialist Library.—Prof. F. E. Sandbach: Some Notes on the Library Co-operation Committee and its Scheme of Inter-lending between University Libraries.

SATURDAY, SEPTEMBER 26.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (Conference at Balliol College, Oxford), at 9.30.—Miss R. Rankin: The Special Library Movement in America.—T. Coulson: Impressions of the 16th Annual Conference of the Special Libraries Association at Swampscott (Mass.), June 1925.—M. Otlet—Prof. Alan Pollard: L'Institut International de Bibliographie et its Methods.—Prof. Gilbert Murray: Some Notes on the Work of the Committee on Intellectual Co-operation of the League of Nations.—At 2.30.—T. H. Burton: Abstracting.—L. S. Jast: Some Special Methods of Cataloguing Temporary Material.—H. L. Robinson: A Central Index of Technical Publications.—R. Borlase Matthews: Efficient Filing.—At 5.30.—Dr. A. E. Cowley: The Relation of the Bodleian to Special Libraries.—At 8.—H. A. Slack: The Information Work of the Daily Press.—L. Pendred: The Inquiry Service of the Technical Press.—Major W. E. Simnett: Co-ordination of Technical Intelligence



SATURDAY, SEPTEMBER 26, 1925.

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The National Need of Scientific Research and Research Workers.

THE Prime Minister, in his speech to the House of Commons on June 29, expressed the view that, to find a way out of our present economic difficulties, one of the essential steps is "to link up science with our industries to-day." Lip service to this ideal can generally be obtained easily in most quarters, whether industrial, scientific, or political. It is when we come to discuss practical methods of realising the ideal that differences of opinion become most marked. The fundamental problem was admirably stated in the annual report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1921-22 (Cmd. 1735):

"The problem before the country, as we see it, is to provide a means which will enable its population of nearly 50,000,000 to live and prosper. It is well recognised that for four-fifths of their food and for a great part of the necessary raw and semi-manufactured materials for industry, the people of these islands are dependent on supplies from overseas. These supplies can only be obtained if this country is able to carry on its exporting industries in future with greater efficiency than the rest of the world, for it is doubtful whether we can compete, either by lowering wages beyond the limits of our competitors, or by securing a much greater human effort than they. If these two avenues are closed, competition, in the end, is confined to greater efficiency resulting from scientific work, for, in the long run, our outstanding business skill and organisation could not make good a deficiency of production or an obvious inferiority in our goods. We consider that scientific and industrial research . . . is an essential factor in the national effort on which the continued maintenance of our present population unquestionably depends."

Two publications of recent issue have redirected attention to certain aspects of this problem. The Research and Inventions Committee of the British Science Guild (6 John St., Adelphi, W.C.2) has issued a report, published as a pamphlet, entitled "Scientific Research Workers and Industry." The National Union of Scientific Workers (25 Victoria St., S.W.1) has recently issued, under the title "On the Encouragement of Fundamental Research," a report of the Research Committee of that body, presented to and adopted by the Council. The two pamphlets are complementary, each to the other; the National Union of Scientific Workers confining itself to "fundamental" research of a purely theoretical nature, the British Science Guild being concerned with scientific research having a direct relation to industry.

The publication of the British Science Guild is an admirable document, from which it is easy to see that great pains have been taken to acquire a solid basis of facts, often in face of great difficulties and of the

reluctance or failure of those bodies having the knowledge of the facts to impart them. In a brief introduction and historical summary, it is pointed out that the Duke of Devonshire's Royal Commission on Scientific Instruction and the Advancement of Science set forth in its report, forty-five years ago, the paramount importance of scientific research, and urged the universities to assist in its promotion, stating that it was to the universities that the country must primarily look for its scientific workers. Neither the State nor the older universities, to which the appeal was made, took any serious steps to supplement the inadequate supply of scientific workers. The War opened the eyes of the country at large, and, since the War, developments in education and the establishment of the Department of Scientific and Industrial Research have already done much to foster scientific research and to bring about its better co-ordination with industry. "Undoubtedly," says the Committee, "the supply of scientific workers has been greatly augmented and the question now arises as to the use made of them in industry." It is to this question that the Committee directed its labours and with which its pamphlet deals.

Dealing with the supply of trained scientific research workers, the Committee of the British Science Guild, after an informative statistical statement of the data obtained by its inquiries, comes to the following conclusion: "It appears that Great Britain has now just about reached the pre-War standard of Germany and the United States, judged by the ratio of students to population, but there is no reason to suppose that the other two countries have remained stationary, consequently there is no justification for deciding that we have now raised our educational status to a position worthy of our place among the other nations, and that there is no need for further expansion." It is pointed out, however, that the universities are short of money and expansion in research facilities is consequently curtailed, despite the facts that the total income of the British universities has been more than doubled, while the annual Parliamentary grant is now nearly five times that of the pre-War period.

As to the utilisation of scientific research workers in industry, the chemical and engineering and allied industries probably employ most of the scientific research workers now engaged in industry. An attempt has been made to get scientific research domiciled in other industries by the establishment, under the ægis of the Department of Scientific and Industrial Research, of industrial research associations for a number of important industries. Very valuable work has been done already by these research associations, but, except in one or two instances, they do not appear to the Committee to be very extensively developed, the

number of scientific research workers employed by them being comparatively small.

The Committee of the British Science Guild says, however: "The success of the Associations, so far as they have been developed, justifies in our opinion the very fullest extension of their activities." The Committee makes several constructive suggestions to this end. In one of these suggestions it has already been anticipated in fact, namely, that the Government could offer considerable inducement to commercial firms to support research by permitting sums devoted to this purpose to be treated as trade expenses for the purpose of assessment for taxation. By an arrangement with the Department of Scientific and Industrial Research, the Inland Revenue does allow the *annual* subscriptions of industrial firms to research associations to be so treated as a trade expense, and, moreover, the income of the research associations so derived is not subject to income tax.

After pointing out "the vast gap there is, in many cases, between laboratory discovery and the commercial exploitation of a process," a gap often bridged only by years of skilled work, the Committee, in an Appendix, submits a memorandum on a proposed advisory committee on industrial inventions. This committee would consist of experts and would have the following functions:

(i) To examine the claims of inventions and to decide which are of probable industrial value.

(ii) To arrange for the semi-large scale, or complete commercial trial, of these inventions which are passed by the committee.

This is a valuable suggestion. The Conference of Research Associations, at its meeting in July last, discussed the same problem, how to bridge the gulf between laboratory discovery and the large-scale application of the discovery to industry. It is too big a question to be dealt with adequately here and now. In many cases, but not in all, it is mainly a question of financing the large-scale trials needed; and it has been suggested that, over and above the funds available to the research associations for research as generally understood, there should be some development fund out of which grants could be made for this specific purpose of shortening the "lag" between discovery and application.

The Committee of the British Science Guild directs attention also to the scheme adopted in the "A. D. Little" Laboratories in the United States, and suggests that a similar organisation "not in any way in competition with the existing Industrial Research Associations, but as a supplement to their activities," would perform a very useful function in Great Britain.

This publication of the British Science Guild is

certainly a most helpful and constructive contribution to the solution of the problem, how "to link up science with our industries to-day." That problem will not be near to solution, however, until our manufacturers generally come to regard scientific research as essential a part and parcel of industrial organisation as are, say, insurance, advertisement, and sales organisation.

We have but little space left to deal fully with the pamphlet issued by the National Union of Scientific Workers. Much of it, perhaps necessarily from the scope of the subject, is rather of the nature of moral exhortation than of concrete proposal, and it reads at times a little tritely. Nor are the authors always successful in "jining their flats." After declaring that the distinction between "pure" science and "applied" science, whether valid or not, is irrelevant to their purpose, they proceed to draw a vital distinction between "fundamental" research and "practical" research, as though this were not pretty much the same thing; and this distinction they base on what must generally be difficult, if not impossible, to determine, the "motives" which inspire the research workers. Who can say what these motives are? Some day perhaps we shall reach that happy state in which it will no longer be worth while to define "pure" and "applied," "fundamental" and "practical," as applied to scientific research. We shall be content to plead for thorough research, confident that if the research be thorough, the "pure" will look after the "applied," and the "practical" will not neglect the "fundamental."

Nevertheless, the National Union of Scientific Workers has performed a most useful service in directing attention to the paramount necessity, apart from any question of its practical application, of scientific research. It points out that the encouragement of research involves the arousing of a right attitude towards research among the general public and the provision of the right atmosphere for the research worker, and makes important suggestions as to financial provision for research.

Birth-Control: Individual and Social Ethics.

The Ethics of Birth-Control (Report of the Special Committee of the National Council of Public Morals.) Pp xvi+179 (London. Macmillan and Co., Ltd., 1925.) 2s. 6d. net.

THIS is a curious publication. The spirit in which the Committee approached its task may be judged from the introductory remarks of the chairman, the Bishop of Winchester. In these he says that many people regret the public discussion now given to such

topics as birth-control, and that "in large measure the Committee share that regret."

It is this attitude which is in itself a serious matter. Here is an invention—the mechanical and chemical control of conception—which is one of the few important biological inventions made in historical times. The discovery of anæsthetics and that of various methods of killing or weakening the action of harmful bacteria are the only others that are in the same street with it. It points a practical way to a final satisfactory control by man of his own evolution, since the only other regulators of numbers which are not merely pious wishes are war, pestilence, famine, or overcrowding. Yet a serious body of public men regret, decades after its widespread adoption in practice, that it should be *discussed*.

Many biologists and students of medicine remember the nausea which rewarded their first dissection or their first post-mortem. It is a natural and almost instinctive reaction, and yet it is their duty and their privilege to be able to overcome it and so devote themselves to the search for truth or the relief of suffering. The cases are precisely parallel.

The net result of the Committee's deliberations is that its members continue to sit on the fence. They find that the use of contraceptives may in special medical or even economic circumstances be advisable, but that self-restraint should always be the ideal. One paragraph in especial deserves quoting as a dogmatic statement which to many will seem simply at variance with fact, and at any rate begs the question. "The use of contraceptives is a symptom of the artificial character of our civilisation whereby for large numbers of people a simple healthy normal married life is difficult and in some cases all but impossible." Even from this very moderate condonation of birth-control, a minority, including Canon Lyttelton, dissent. They say that the use of contraceptives is *never* to be condoned, and give as their chief reason that it is unnatural ("a frustration of God's design in Nature").

It would be very interesting to know which of the activities of civilised man the minority would call natural. When I used to meet Canon Lyttelton regularly—when I was under him in Sixth Form at Eton—he (*inter alia*) taught us Latin, Greek, and Divinity, and did his best to stop beagling in the school. Now I would quite respectfully submit that these activities are no more natural—or unnatural—than the practice of birth-control; and one of them—the antipathy to chasing wild animals—though I sympathise with it personally, yet is in direct opposition to one of the most ingrained "natural" propensities of humanity.

No: to damn a practice because unnatural is logically, to revert to a senseless Rousseauism. From

one point of view civilisation is all unnatural. From another it is all natural, since it all springs from the nature of man: and as a matter of fact, the qualities in it which are usually regarded as more natural are just those which we share with the brutes, not those peculiar to our human dignity, and more often than not need repression instead of encouragement. It is meaningless to judge the practices of civilised man on this basis: they may justly be appraised as right or wrong, or as useful or harmful—but natural or unnatural, no.

Turning to the majority report, we find another defect which is characteristic, unfortunately, of too many idealists, both within and without the Church. They consider what they would like to see in existence, while partly or wholly neglecting what is in existence; and they run to extremes. It is pretty obvious that we should prefer to see more self-control in marital relations rather than more self-indulgence. But they do not seem to have reflected that such self-control as they recommend is not and certainly will not be for centuries "practical politics" for the mass of the human race. Among the distinguished people who gave evidence we find medical men, philosophers, social workers, clergymen, and others: one figure is conspicuously absent, and that is "l'homme moyen sensuel"—the type of the mass for which the Committee aspires to proscribe. For at least half the population for generations to come, the alternative to contraceptive methods is not self-control but the reverse, with as a result excessive child-bearing, with consequent misery, ill-health, poverty and degradation of standards.

Further, if there is one thing that is clear, it is that contraception has come to stay. Sir William Beveridge has made it fairly clear that to no other cause than the improvement of contraceptive methods can the marked drop in the birth-rate which started some fifty years ago be ascribed; for the suggestion of Brownlee that we are dealing with some undefined phenomenon of race-fertility cannot be entertained without much more cogent evidence.

Then our Committee runs to extremes. It may be true, as we said, that *more* marital self-control would be a good thing; but that does not in the least imply, as an elementary acquaintance with logic will convince, that *complete* self-control, save for the deliberate purpose of producing children, is the ideal. It is undoubtedly true that more self-control in the matter of eating would be a good thing, both morally and physically, for the nation; but that does not make complete abstention from food the ideal. A more real parallel is between the two aspects of eating and the two aspects of marital relations. We must eat to live,

but we can also enjoy our food for its own sake. So we must practise marital relations to reproduce our species; but we can also find in them a means, as the Quakers put it, of "mutual endearment," or, in the more flaming words of Blake, make of it "that . . . on which the soul unfolds her wing." If we are to refrain from all intercourse save that intended for procreation, we must logically disapprove of all devices, such as good cooking, designed to promote enjoyment of food, instead only of gluttony.

Finally there remains the biological aspect. The drop in the birth-rate has been differential. That of all classes used to be the same: in the last half-century or so the birth-rate of the professional and upper classes has fallen much more than that of the rest of the population. Although this is not such a dysgenic matter as is sometimes made out, since some very good stock, such as those of miners and agricultural labourers, show little drop in fertility, yet it *is* dysgenic: the proportion of desirables is decreasing, of undesirables increasing. The situation must be got in hand. But it is impossible to persuade the classes which have adopted contraceptive methods to drop them by idealistic appeals to self-control. The way to begin to stop the rot is to diffuse these practices equally through all strata of society. Then and only then can we draw breath and look round for more constructive eugenic remedies. But, meanwhile, as Mr. Wells in his letter in NATURE of July 25 suggests, we have no cause to be complacent about our intellectual and social freedom as compared with Tennessee, in the matter of birth-control we are doing a similar thing; we are preventing servants of the State from giving information on a vital topic, largely because of the attitude of certain religious bodies to the topic. Not only thus, but while thus preventing the giving of the information where it is most needed, we take not the slightest steps to prevent it being given in a thoroughly unpleasant way, on a commercial basis—to those who can pay for it.

I make no apology for dealing with the subject at such length. We have here one of the most urgent matters of applied science with which our civilisation has been called upon to deal. Let us not bungle it as we bungled the whole human and social side of the application of science to industry at the time of the industrial revolution. I would recommend the separate report signed by Dr. Bond alone of the Committee as embodying a very cautious but a very sane attitude.

This booklet is interesting for much of the evidence which it contains; it is also interesting as showing that the Churches are alive to the existence of the problem. But we must regret that the report on the whole allows the question to fall to the ground between, on the one

hand, the stool of "natural" repugnances which ought to have been long ago overcome, and the stool of over-idealism on the other. When all is said and done, there is very little guidance here of a practical or social sort. The "ethics" of the book's title are chiefly individual ethics; the social ethics of the question are less fully and less broadly discussed. The over-concern of the individual for the salvation of his own soul was a characteristic of the Middle Ages. It springs up when there seems to be no prospect of reconciling the organisation of society with religious and moral ideals. To-day we do not feel that as an impossibility—however hard the task obviously will be, we see society as more plastic. We must be very careful not to allow the individual's concern about his own soul to loom so large as to stand in the way of social improvement or to block the social view. It would be an interesting task to try to discover how far the acknowledged lack of grip of the Church on the nation to-day comes from the retention of this spirit, which, however necessary a product of medieval times, is out of place in a society the leading minds of which are upheld by the consciousness that man through knowledge may acquire conscious control of evolution. But that is another story!

J. S. HUXLEY.

Mining and Metallurgy in the British Empire.

Empire Mining and Metallurgical Congress, held in London, June 3-6, 1924. Proceedings Part 1: General Section of Congress. Edited by the General Secretaries and G. F. Bird and Percy Strzelecki. Pp. xv + 474 + 14 plates. Part 2: Mining (Section A of Congress.) Edited by the General Secretaries and G. F. Bird and Percy Strzelecki. Pp. xvi + 542 + 25 plates. Part 3. Petroleum. (Section B of Congress.) Edited by the General Secretaries and Dr. A. E. Dunstan. Pp. xvi + 239 + 21 plates. Part 4: Metallurgy of Iron and Steel. (Section C of Congress.) Edited by the General Secretaries and L. P. Sidney. Pp. xiv + 296 + 14 plates. Part 5: Non-ferrous Metallurgy. (Section D of Congress.) Edited by the General Secretaries and G. Shaw Scott. Pp. xii + 137. (London: Empire Mining and Metallurgical Congress, 225 City Road, 1925.) Parts 1, 3, 4, 5, 10s. 6d. each; Part 2, 21s.; Set of 5 vols., 42s.

THE records of the proceedings of the first Empire Congress of Mining and Metallurgy have now been published in five substantial volumes, which will be found to contain much of interest to every one engaged in any branch of the numerous industries included under the headings mentioned in the titles of the volumes. It must not, however, be supposed that the

importance to the British Empire of last year's Congress can be in any way properly gauged by the printed record of its proceedings. The real value of this Congress is to be found rather in its personal touch, in the essential fact that this was the first occasion upon which the men engaged in developing the mineral resources of the British Empire met together in conference, made each other's personal acquaintance and were able to discuss, both formally and informally, the numerous perplexing problems which they are called upon to solve in their daily routine. It may safely be said that the most valuable work that was done at the Congress was the work that will never be published, the heart-to-heart exchange of views for which it afforded so many opportunities, and to which the formal papers, which now lie before us in their permanent form, were so often looked upon mainly in the light of more or less unwelcome interruptions.

The importance of the subject-matters of this Congress can scarcely be overestimated, including as they do the employment in the service of mankind of the mineral wealth of our vast Empire; let it be remembered that the utilisation of the earth's mineral resources embodies human civilisation. The savage can live and does live on the organic products of the earth; but the dawn of civilisation only arose when man began to avail himself of the earth's inorganic products also, and every advance in civilisation and in the amenities of life depends upon the fuller and better use made of mineral resources. The work of mining and metallurgical technologists consists in discovering how to use these resources to the best advantage and how to supply them in the vast quantities and at the comparatively reasonable cost which the complexities of our modern existence imperatively demand. It is for this purpose mainly that the technologist calls upon science to come to his aid, and, as the records before us abundantly show, the application of scientific principles is playing an increasingly important part in helping the development of the mineral resources which Nature has placed at the disposal of mankind; never was there a time when the need for the employment of scientific methods was more urgent, for it would almost appear as though this were the only direction in which it is possible to seek for a remedy against the prevailing creed of work-shyness from which the Empire and Great Britain, in particular, are to-day suffering.

Whatever science and technology may effect, the basal fact remains, that we must necessarily look to labour to carry out the methods which the trained mining engineer and metallurgist may devise. In his recent presidential address to the Iron and Steel Institute, Sir Frederick Mills showed that the cost of production of all ordinary commodities includes from 90 to 95 per

cent. labour cost, and this high figure emphasises strikingly the fact that it is labour alone which, in the ultimate resort, determines whether the articles which modern civilisation demands shall or shall not be supplied at a reasonable cost. This point was admirably put quite recently in another presidential address, that of Sir Thomas Holland to the Institution of Mining and Metallurgy, and his words are worth quoting :

"As civilisation, such as we know it, depends absolutely on our being able to rely on supplies of the base metals, each improvement in the treatment of ore adds enormously to the actuarial value of civilised life. On the other hand, every increase in the cost of mining and metallurgical operations renders inaccessible correspondingly our available reserves. As labour is the most important item in our working costs, a trades' union meeting can undo in a morning the results of a generation's research work in ore-dressing and metallurgy."

It is considerations such as these which serve to show the Empire Congress of Mining and Metallurgy in its true light as a bulwark of civilisation, based on the co-operation of those engaged in furnishing humanity with those materials which it has learnt to regard as indispensable to its present comfort and future progress. Towards the attainment of this object, the free interchange of ideas between all English-speaking mining engineers and metallurgists (for it must not be overlooked that, in spite of the title of the Congress, American technologists were good enough to take part in it and to share in the deliberations of their British fellow-workers, to the great delight of the latter) is perhaps the most effective means that could have been devised.

To turn to the published proceedings, it has already been indicated that they form the least important part of the real work of the Congress, in spite of the fact that they contain much information of the greatest use to students of technology. There are five volumes, the first dealing with general subjects, and the four others devoted respectively to mining (coal and metalliferous), petroleum, iron and steel, and the non-ferrous metals. The first volume contains a certain amount of what may be considered as ephemeral matter, records of proceedings, speeches at the Guildhall banquet, etc.; but together with these there are three general papers of very great importance, namely, general reviews of mining and metallurgical practice in three great sections of the British Empire—Canada, Australasia, and South Africa—each of which contains a wealth of information concerning the development of their respective mineral resources which could only have been brought together on such a unique occasion as this Congress presented. Perhaps it may be regretted that the Canadian paper

deals somewhat too exclusively with the mining side of the question and that the great metallurgical developments in Canada are not adequately represented.

The mining papers contained in the second volume, with but few exceptions, deal with the broad general problems of mining, such as should properly be considered at an Empire Congress, where detailed discussions of any one particular district are perhaps somewhat out of place. A number of these papers are devoted to a review of general economic conditions, applicable to mining generally, and cover the broad field which more particularly interests such a Congress, whilst it is a highly significant fact that fully half of the papers are devoted to the all-important considerations of the safety, health, and wellbeing of the men engaged in mining operations. It is surely a good sign that although Britain holds to-day the proud position of conducting its mining operations with a higher standard of safety than any other country in the world, we are not content with having reached this stage, but are striving onwards towards a still greater measure of security for the underground worker.

The volume on petroleum may fairly be regarded as one of the best of the series, each paper dealing with one or other aspects of the subject, the economics, the geology, the methods of exploitation, the after-treatment and the storage and transport of the products being each one fully considered, so that this volume presents a complete epitome of the petroleum industry as it exists in the world to-day. It may fairly be asserted that papers such as the above, showing the stage which the development of an industry has attained, are not only the most suitable for presentation to a Congress but also likely to prove of the greatest permanent value to the future student of the subject.

The volume devoted to iron and steel is necessarily less homogeneous than the last named, because the great complexity and numerous ramifications of this vast industry prevent any similar general treatment of the subject as a whole. There are, however, a number of broad papers which deal particularly with the various principal branches, such as a review of coke manufacture, of fuel economy in general, of blast-furnace practice, of the production of various special steels, and of the economics of the iron and steel industry, whilst two papers describing the progress of the industry in Canada and in India respectively are of very special importance.

The last volume, dealing with the non-ferrous metals, is perhaps the weakest from the point of view of an Empire Congress, but this again is due in a measure to the fact that it is called upon to cover so wide a range. It falls to the lot of but few men to acquire a satisfactory working knowledge of more than one of the many

metals included in the non-ferrous group, and hence the presentation of general papers becomes a problem of extreme difficulty. Several of the papers, such as that of Dr. Rosenhain and Mr. Archbutt on the alloys of aluminium, form important contributions to our knowledge of one particular metal, but would perhaps be better suited to the pages of the Journal of the Institute of Metals than to the records of an Imperial Congress, where breadth of vision is of more importance than microscopic accuracy of detail.

It would not be right to conclude this notice without some reference to a matter which, although it occupies but an insignificant place in these volumes, being comprised within two pages of letterpress, will possibly prove to be the most important outcome of the Congress, namely, the foundation of an Empire Council of Mining and Metallurgical Institutions. This Council proposes to act as the organ of co-ordination and co-operation between all these institutions throughout our wide-flung Empire, and, it is hoped, will form a common bond between all British mining engineers and metallurgists. It should enable them more effectively to pool their knowledge and experience and to foster the already existing feelings of true comradeships between them. In this way it should advance still further the development of our Imperial mineral resources, thus playing an important part in strengthening and maintaining the British Empire.

HENRY LOUIS.

The God of Aristotle.

Aristotle's Metaphysics. A Revised Text, with Introduction and Commentary, by Prof. W. D. Ross. Vol 1, pp. clxvi + 366. Vol. 2, pp. iv + 528. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 2 vols. 48s. net.

IN preparing this new edition of Aristotle's *Metaphysics*, Prof. Ross has performed an arduous and a valuable service. From many points of view the *Metaphysics* may be regarded as the hardest nut which Prof. Ross has in the course of his great undertaking yet had to crack, and it is doubtful whether any of the works of Aristotle which have still to appear will present equal difficulty. In the first place, the text is incredibly corrupt. The earliest MS. we possess is separated from Aristotle by a distance of twelve centuries, some of the books which are included are clearly intended to form part not of this but of a different work, other books necessary to the argument are missing, while there is acute controversy over the correct order of the books we have. Finally, Aristotle's writing bears, even more clearly than in his other works, evidence of being, not a mature treatise, but a series of notes for lectures or jottings

preliminary to the preparation of such a treatise, the consequence being that, partly owing to the clipped and allusive character of Aristotle's remarks, partly owing to the gaps caused by the mutilation of the text, the amount of matter that has to be supplied by conjectural emendation is exceptionally large.

The *Metaphysics* is exceptional, too, in the amount of controversy it has aroused; for the argument—and this is the second great difficulty with which Prof. Ross has had to contend—if of unusual difficulty even for Aristotle, full of contradictions, repetitions, definitions which are neither used nor kept, preliminary statements which have no sequels, and divisions of subject-matter which are elaborately made only to be cut across by later and incompatible divisions. The consequence is that when you have to use what Aristotle did say as a basis on which to conjecture what he may have said, while many guesses are plausible few can be more than guesses; so that different commentators have been able to indulge themselves even more freely than usual in their old trick of seeing in disputed passages confirmation for their own particular views.

Through all this tangle of controversy and conjecture Prof. Ross keeps a clear head. He is sane in suggestion, sensible in judgment; he never advances a view without giving good reasons for it and for the rejection of contrary views, and he displays a knowledge and writes with an authority which fully entitle his edition to be ranked among the nobler works of scholarship. Most valuable is a clear and full statement of the probable views of Socrates and Plato as disclosed by references in Aristotle, of the metaphysical views of Aristotle himself, and of his highly peculiar theology.

I say views advisedly, and not system, for of all works on *Metaphysics*, Aristotle's is surely the most tentative and empirical. There is no statement of general principles, no ordered advance from agreed premises, but tentative suggestions, fresh starts and reduction of common-sense views to more precise terms. As Prof. Ross puts it, the *Metaphysics* "expresses not a dogmatic system but the adventures of a mind in its search for truth."

It is matter for surprise that these adventures have attained their enormous celebrity. Taken in the broad, Aristotle's speculations, especially with regard to the profounder truths, unlike those of Plato which give pleasure even when they do not carry conviction, are neither intellectually convincing nor æsthetically satisfying. They owe much of the veneration with which they have been regarded to their somewhat arbitrary selection by the early Catholic Church as a basis for its theology. Aristotle was the first to bring into philosophy the conception of "the prime mover" as the ultimate principle of the universe, a prime mover

who was spirit and not matter, and stood at the head of a hierarchy of spiritual essences. This conception seems to have been enough for the Christian fathers. Yet it is surprising that they should have embraced it so readily. Aristotle's cosmology is one of great clumsiness; he announces six different kinds of being as the constituents of his universe, the prime mover, intelligencies actuated by love of him fifty-five in number, the soul of the first heaven, the souls of the fifty-five spheres, the first heaven, and the fifty-five spheres, and he makes no effort to resolve this somewhat grotesque plurality. Furthermore, Aristotle's prime mover was not the creator of the universe, since matter is eternal, nor is he a personal God feeling interests outside his own concerns, nor is he a God of love, since to entertain emotion would be to interrupt contemplation. Contemplation is, indeed, the one pursuit of the prime mover, the objects upon which his intellect is directed being geometrical problems.

In this, and indeed in other respects, Aristotle's prime mover is more like the ancients in the last play of the "Back to Methuselah" Pentateuch than the God of any known religion. They, too, are engaged in the study of mathematics; their creator shares Aristotle's distrust of emotion and his respect for intellectual activity as the end and purpose of existence

C. E. M. JOAD

Our Bookshelf.

Allen's Commercial Organic Analysis. Vol. 3. Hydrocarbons, Bitumens, Naphthalene and its Derivatives, Anthracene and its Associates, Phenols, Aromatic Acids, Gallic Acid and its Allies, Phthalic Acid and the Phthaleins, Modern Explosives. Fifth edition, revised and in part rewritten. Edited by Samuel S. Sadtler, Dr. Elbert C. Lathrop, and C. Ainsworth Mitchell. Pp. ix + 732 (London: J. and A. Churchill, 1925.) 30s. net.

THIS new volume, while showing many changes in the personnel of the contributors, and some increase in size, very closely follows the ground covered by the corresponding volume in the previous edition published fifteen years ago. The only definite change would appear to be the separation of the text on benzol with its derivatives from bitumens, so that it may be included later with dye-intermediates. With the extra space available, many of the more recent developments in analytical chemistry have received consideration. The newer indicators for hydrogen-ion control and the comparative testing of antiseptics, to mention but two subjects, have received special attention.

In spite of the fact that a large number of slips appear to have escaped the proof-reader, especially among the chemical formulæ (e.g. copper sulphate, p. 150, trinitroresorcinol, p. 337, and cellulose trinitrate, p. 598), the very high standard of the fourth edition has been maintained and all the sections have been brought up-to-date.

In the examination of tars, pitches and oils, American standard methods have been followed. A good account is given of the testing of natural gas in the bitumens section, but in the detailed description of the Orsat-Burrell apparatus the figure appears to have been omitted. The fact that the testing of salicylic acid is given thirty pages and saccharin twenty pages, to take only two examples, gives some idea of the thoroughness with which this standard work is compiled. The explosives section has been doubled in size since the last edition. A big portion of the increase, however, is due to the inclusion of long extracts from the First Report of the Home Office Departmental Committee on the Heat Test (1914). The curious diagrams of this report, with dimensions inserted on simple apparatus to the third and fourth decimal point, are also reproduced. The reference to Silberrad Ablett and Merryman (p. 613) for the estimation of nitroglycerin in cordite, although similarly given in some other text-books, is incorrect; it should read Silberrad, Phillips, and Merri-man. The poor reproduction of Will's apparatus (p. 704) makes the lettered description in the text of little value. It is incorrect to dry tetryl by heating above its melting point (p. 641) before determining this constant. Reference is made in the explosives section to the new gelatinisers and stabilisers, such as diethyldiphenylurea and unsymmetrical diphenylurea, which were largely used in Germany during the War in the manufacture of propellants. No method of testing these products is given, as it is stated that no method has hitherto been published. J. REILLY.

Pathologische Pflanzenanatomie. In ihren Grundzügen dargestellt von Prof. Dr. Ernst Kuster. Dritte, neu bearbeitete Auflage. Pp. xii + 558 (Jena: Gustav Fischer, 1925.) 24 gold marks.

THE field of pathological plant anatomy is a difficult one to define, and the author has interpreted it in a broad sense. This book, which now appears in a third and enlarged edition, fills much the same place in relation to pathological plant anatomy that Haberlandt's well-known work does to the "physiological anatomy" of normal plant tissues and organs. It is an abundant source of carefully sifted information on the anatomy of pathological growths in their multiform variety. Numerous clear illustrations add greatly to the value of the work.

The special part opens with an account of variegation, which occupies about 40 pages and deals with much of the modern literature of the subject from an anatomical point of view. The second chapter is devoted to etiolation, the effects of the absence particularly of the short rays of the spectrum. Not only the well-known effects on chromatophores and stems are considered, but also the effects of darkness on hair formation, pollen, endodermis, algæ, and fungi. Three other chapters are devoted respectively to intumescences and similar structures involving increase of water content, wound-tissues and regeneration; and galls. The last two topics occupy 160 pages and include a consideration of callus, tyloses, wound cork, and gum formation.

The general part is arranged in three sections dealing with the histogenesis, the developmental mechanics and the "ecology" of pathological tissues, making up the greater part of the book. Here the facts are regarded

from a more philosophical viewpoint. Such general problems as senescence in plants, inhibitions to development, polarity, abnormal cell divisions, cell fusions and necrosis are considered on the basis of definite facts. The examples cited include anything from "involution" forms of bacteria to abnormal reduction divisions and the splitting of tissues by frost. As regards the *Entwicklungsmechanik* of pathological tissues, the causes discussed are classified as mechanical, osmotic, chemical, radiant energy and correlation. Under the latter head brief reference is made to gigantism and polyploidy, while Haberlandt's theory of wound hormones also receives consideration.

The final section deals "ecologically" with such topics as the healing of wounds, formation of aerenchyma and hydathodes, and with functional adaptation of tissues. The book is a most useful reference work for botanical laboratories, for one frequently finds the facts of pathological histogenesis considered from an unstereotyped point of view.

R. R. GATES.

Practical Chemistry by Micro-Methods. By Prof. Egerton Charles Grey. Pp. ix + 124. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1925.) 4s. 6d. net.

FORTY years have now elapsed since the appearance of Haushofer's "Microscopic Reactions," and the science of qualitative microchemical analysis, of which it was the sign and portent, seems to have remained indigenous to Central Europe. Behren's "Introduction to Microchemical Analysis," the first edition of which was published in 1899, has become almost a classic, and the text-books of Schoorl and Emich have also achieved a well-earned reputation. Prof. Grey's elementary introduction to microchemical work is, we believe, the first English book to deal with this subject, and in extending a welcome to it, we hope that it will be the means of spreading the use of the microscope in chemical work.

Microchemical reactions are for the most part more decisive than the ordinary microscopic tests; they necessitate greater cleanliness and entail greater economy in time and material. Notwithstanding these facts, we cannot agree with the author that microchemical analysis should be substituted for ordinary analysis in our schools and colleges, though we grant that, at the appropriate stage, nearly every student would gain from such a course as he prescribes. It is a trite criticism that many secondary schools attempt work which is much better left to the university; here is a subject which pupils in their last school year could pursue with great advantage, and with this manual in hand they could work with very little supervision from the teacher. The low price of the book is also a recommendation, and prompts the question if it heralds a new dawn of cheap—and good—printing and publication.

Elements of Physical Biology. By Dr. Alfred J. Lotka. Pp. xxx + 460. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1925.) 25s. net.

For a long time methods analogous to those of statistical mechanics have been applied to animal and plant communities. But just as in physical chemistry these methods soon become intolerably cumbrous and may generally be replaced by thermodynamical calculations which ignore the individual molecule, so in the book

before us the author has applied to biological problems a treatment of the type familiar in chemical statics and kinetics. These methods are applied to the growth of populations, whether of bacteria, insects, men, or railway engines, and to relationships between different species, for example, between a parasite and one or more hosts. The author has the problem of evolution always before him, and considers analytically the effect on population of a change in the behaviour of individuals.

It must not be supposed, however, that the book is a mere formulation of theories. It contains a vast amount of facts unattainable within the same compass elsewhere. For example, the account of the circulations of hydrogen, carbon, nitrogen, and phosphorus in Nature is the most satisfactory known to the reviewer, and accounts are given of the experimental work of Pearl and his pupils on animal populations, and the statistical results of Willis and Yule on "age and area." No biologist conversant with mathematics can possibly read this book without coming upon many ideas which will be new to him, and many mathematicians will find in it applications and problems of a refreshing novelty.

The Folklore of Fairy-Tale. By Macleod Yearsley. Pp. xiii + 240. (London: Watts and Co., 1924.) 7s. 6d. net.

In his brief preface, Mr. Yearsley modestly denies himself any claim to originality. His object is to bring together in a concise and popular form the salient points in the science of fairy-tales. He confines himself, where possible, to those tales which are current in the British Isles or have been introduced and popularised by British writers. His material, therefore, is largely drawn from Grimm and Perrault. In discussing the scarcity of the indigenous *marchen* type in Britain, he follows Hartland in attributing its suppression to the influence of Evangelical Protestantism. On this point he might have enlarged to the advantage of his readers. Hartland's suggestion indicates an important contributory cause, but it by no means entirely explains the facts. Why, for example, do British *marchen*, with one or two exceptions, survive especially in the areas in which revivalism usually flourishes? Mr. Yearsley illustrates his argument throughout with numerous examples and parallels. As many of the sources from which he draws his material are out of print or too technical for the ordinary reader, his book adequately serves the purpose for which it is intended.

An Elementary Chemistry. By E. J. Holmyard. Pp. viii + 424. (London: Edward Arnold and Co., 1925.) 5s.

MR. HOLMYARD's book covers the syllabuses for the various First School Certificate and the London Matriculation Examinations. It is brightly written with a modern outlook, and should appeal to young students. Questions for exercise and useful "Revision Notes" (at the end of the book) are provided. Interesting historical notices, some portraits of famous chemists, and reproductions of manuscripts and pages of famous books enliven the text, and the whole treatment may be commended. The author has evidently appreciated the common difficulties and mistakes of young students, so that his experience may also be of assistance to teachers.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.*]

The Taungs Skull.

IN NATURE of July 4, 1925, p. 11, Sir Arthur Keith has attempted to show first that I called the Taungs skull a "missing link," and secondly, that it is not a "missing link."

As a matter of fact, although I undoubtedly regard the description as an adequate one, I have not used the term "missing link." On the other hand, Sir Arthur Keith in an article entitled "The New Missing Link" in the *British Medical Journal* (February 14, 1925) pointed out that "it is not only a missing link but a very complete and important one." After stating his views so definitely in February, it seems strange that, in July, he should state that "this claim is preposterous."

Despite this reversal of opinion, Sir Arthur tells us that the skull "does show human-like traits in the refinement of its jaws and face which is not met with in young gorillas and chimpanzees at a corresponding age." He appears to have overlooked the fact that in addition to these and other facts brought forward by myself, the temporal bone, sutures, and deciduous and permanent teeth (according to Dr. Robert Broom) also show human-like traits. Moreover, as Prof. Sollas has so ably shown, the whole profile of the skull is entirely different from that in living anthropoids, thus indirectly confirming my discovery that the brain inside the skull-dome which caused this profound difference was very different from the brains inside the skulls of modern apes.

The fact that Sir Arthur was unable to find the *parallel sulcus* depression in the replica cast sent to Wembley illustrates how unsatisfactory the study of the replica can be in the absence of the original.

With reference to the question of endocranial volume, I would state with Prof. Sollas that this "is a matter of only secondary importance." Nothing could exemplify this matter better than the condition of affairs in the Boskop race, where the endocranial volume was in the vicinity of 1950 c.c. (The average European's endocranial volume is 1400-1500 c.c.) Indeed, the world's record in human endocranial volume (2000 c.c.) was discovered in a "boskopoid" skull by Prof. Drennan in a dissecting room subject at Capetown this year. It is well known that the elephant and the whale have brains much larger than those of human beings, but no one has inferred from that that their intelligence is greater. It is fairly certain that size of brain has some relation to size of body, as Dubois has shown. It is highly probable that the australopithecoid man-apes were relatively small as compared with the gorilla. It is not the quantity so much as the quality of the brain that is significant.

Sir Arthur is harrowed unduly lest the skull may be Pleistocene. It is significant in this connexion that Dr. Broom, who first directed attention to this possibility (of which I was aware before my original paper was sent away), regarded it nevertheless as "the forerunner of such a type as Eoanthropus." It should not need explanation that the Taungs infant, being an infant, was ancestral to nothing, but the family that he typified are the nearest to the pre-human ancestral type that we have.

In view of these facts, there is little justification

for the attempted witticism that in making the "African ancestors typified by the Taungs infant" the "foundation stone of the human family tree"—whatever that may be—I am making "a mistake identical with that of claiming a Sussex peasant as the ancestor of William the Conqueror." This is merely a case of mistaken identity on the part of Sir Arthur. I have but translated into everyday English the genealogical table suggested by Dr. Robert Broom (NATURE, April 18, 1925), with which I agree almost entirely. I take it, however, as a mark of his personal favour that Sir Arthur should have attacked my utterance and spared Dr. Broom's.

Sir Arthur need have no qualms lest his remarks detract from the importance of the Taungs discovery—criticism generally enhances rather than detracts. Three decades ago Huxley refused to accept Pithecanthropus as a link. To-day Sir Arthur Keith regards Pithecanthropus as the only known link. There is no record that Huxley first accepted it, then retracted it, but history sometimes repeats itself.

RAYMOND A. DART.

University of the Witwatersrand,
Johannesburg

PROF. DART is under a misapprehension in supposing that I have in any way or at any time altered my opinion regarding the fossil ape discovered at Taungs. From the description and illustrations given by him (NATURE, Feb. 7, 1925, p. 195) the conclusion was forced on me that *Australopithecus* was a member of "the same group or sub-family as the chimpanzee and gorilla" (NATURE, Feb. 14, 1925, p. 234). In the same issue of NATURE, Prof. G. Elliot Smith expressed a similar opinion, describing *Australopithecus* as "an unmistakable anthropoid ape that seems to be much on the same grade of development as the gorilla and chimpanzee without being identical with either."

All the information which has come home since Prof. Dart made his original announcement in NATURE has gone to support the close affinity of the Taungs ape to the gorilla and to the chimpanzee—it is a member of that group. Prof. Bolk, of Amsterdam, and Prof. Wingate Todd, of Cleveland, Ohio, have directed attention to the fact that the skulls of occasional gorillas show the same kind of narrowing and lengthening as has been observed in that of the Taungs ape. Prof. Arthur Robinson has shown that there is a wide variation in the size of jaws of young chimpanzees of approximately the same age, the smaller of the jaws approaching in size and shape to the development seen in the Taungs ape. The dimensions of the erupting first permanent molar of the Taungs ape and the form of its cusps point to the same conclusion—that *Australopithecus* must be classified with the chimpanzee and gorilla. It is, therefore, "preposterous" that Prof. Dart should propose to create "a new family of *Homo-simiadæ* for the reception of the group of individuals which it (*Australopithecus*) represents." It is preposterous because the group to which this fossil ape belongs has been known and named since the time of Sir Richard Owen.

The position which Prof. Dart assigns to the Taungs ape in the genealogical tree of man and ape has no foundation in fact. A large diagram in the exhibition in Wembley, prepared by Prof. Dart, informs visitors that the Taungs ape represents the ancestor of all forms of mankind, ancient and modern. Before making such a claim one would have expected that due inquiry would first be made as to whether or not the geological evidence can justify such a claim. From his letter one infers that Prof. Dart does not set much store

by geological evidence. Yet it has been customary, and I think necessary, to take the time element into account in constructing pedigrees of every kind. Dr. Robert Broom and, later, Prof. Dart's colleague, Prof. R. B. Young, have reviewed the evidence relating to the geological antiquity of the Taungs fossil skull, and on data supplied by them one can be certain that early and true forms of men were already in existence before the ape's skull described by Prof. Dart was entombed in a cave at Taungs. To make a claim for the Taungs ape as a human ancestor is therefore "preposterous."

Finally, Prof. Dart reminds me that whales and elephants have massive brains and that many large-headed men and women show no outstanding mental ability. Still the fact remains that every human being whose brain fails to reach 850 grams in weight has been found to be an idiot. Size as well as convoluted pattern of brain have to be taken into account in fixing the position of every fossil type of being that has any claim to be in the line of human evolution—the Taungs brain cast at Wembley possesses no feature which lifts it above an anthropoid status.

ARTHUR KEITH

Royal College of Surgeons of England,
Lincoln's Inn Fields,
London, W.C., September 5.

The Rate of Man's Evolution.

ALL those interested in the important question of man's evolution will have read with pleasure Sir Arthur Keith's recent contribution to this problem in *NATURE* (August 29, 1925). It is with some diffidence, therefore, I record the fact that I am unable to agree with certain of his conclusions. He states in the article above mentioned (p. 317), that the Ice Age terminated "some 12,000 years ago," and again (p. 319), that the well-known palæolithic epoch—the Mousterian—"closed some 20,000 years B.C." It is, however, known that the close of palæolithic times coincided with that of the Ice Age, and thus, according to Sir Arthur Keith's dating, the distinct and widespread civilisations of the Aurignacian, Solutrean, and the Magdalenian, together with the change of climate and of fauna that accompanied them, can have occupied no more than 10,000 years.

Again (p. 319) your readers are informed that "the Chellean phase of culture was moving towards its zenith 100,000 years ago." But, in view of the fact that there is good reason to believe the Chellean phase is referable to the Cromer Forest Bed, and that two major glaciations, with their interglacial periods, have occurred since the Forest Bed was laid down, it is, I think, perhaps unwise to assign any implements of Chellean age to an epoch so comparatively recent as 100,000 years from the present.

To suppose these things is surely to exceed the archaeological and the geological speed limits?

The recent discovery, in a cave in Galilee, of portions of a human skull of Neanderthal type has a direct bearing upon the matter under discussion in this note. In Mr. Turville Petre's account of this find (*Times*, August 14, 1925) he states that the specimens were found in an undisturbed deposit containing flint implements, which "seem to indicate a transition culture from Early Palæolithic, or Acheulean, to Middle Palæolithic, or Mousterian." If this determination is correct, then it is clear that the skull fragments must be referred to the *beginning* of the Mousterian period. Yet Sir Arthur Keith claims, for some unreported reason, that the Galilee individual lived about 20,000 years B.C., which, accord-

ing to his own dating, is when the Mousterian period ended.

As for the antiquity of the modern type of man, I am compelled to conclude, after a review of all the evidence, that the discovery of human bones of this type in ancient deposits at Galley Hill and elsewhere support definitely the reality of this antiquity.

J. REID MOIR.

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The Cause of Surface Tension.

IN an article in *NATURE* for April 4 (vol. 115, p. 512) Mr. N. K. Adam revives the old question as to the reality of a state of tension in the surface film of a liquid, and expresses grave doubts as to its existence. I myself fell into this same heresy in my first flush of enthusiasm over Laplace's theory of capillarity; what eventually led me back into the fold was the contemplation of simple cases like the following.

Consider a drop of water hanging in equilibrium below a hole in the bottom of a vessel of water, and for definiteness let us mean by the "drop" the water below some horizontal plane P drawn very close to the bottom of the vessel. The drop is acted on by two downward forces, its weight, and a net downward push exerted by the water above, for there can be no doubt whatever that over the plane P the hydrostatic pressure exceeds atmospheric.

Now the crucial question is, what upward force balances these two downward forces? It is no good arguing about resultant inward forces on the surface particles of the bottom part of the drop, for not even a water-drop can lift itself by its own boot-straps. Some portion of matter outside the drop must be pulling or pushing upward upon it. The only matter that can be doing this is the contiguous water above the drop. But cohesion by the central part of this water cannot be the cause, for the *net* force exerted by the central part, due to kinetic or contact pressure minus cohesion, constitutes the force of hydrostatic pressure referred to above, and certainly acts downward. We are inevitably driven to the conclusion that the surface skin of the adjacent water above P is, on the whole, pulling upward upon the surface skin of the drop.

This is all that we mean when we say that the surface skin is in a state of tension, any selected portion of the skin pulls harder than it pushes upon each adjacent portion. Note that the maintenance of the equilibrium of a surface molecule is quite a different matter; that depends upon the sum of all pulls and pushes taken together, and has no bearing on the question of the relation between pull and push in a given direction.

This argument is very elementary and old, of course. But I cannot find where any one has pointed out how simply the tension can be deduced also from those same Laplacian conceptions which have proved so misleading to many.

Let us in thought divide the surface skin by a perpendicular plane R , and let us consider a horizontal slab of the liquid of unit width, of thickness dx , and extending perpendicularly from R to a point on the right beyond the molecular range of action, h . The liquid to the left of R will attract this slab with a component of force normal to R equal, say, to tdx ; and it will also press upon the slab with a force pdx where p = intrinsic pressure, which we assume to be equal in all directions at a given point in consequence of the fluidity (We omit the superposed action of the hydrostatic pressure.) Then in the interior

$p=t$, whereas at the surface $p=0$, while t has here just half of its value in the interior, representing the attraction of half of a hemisphere upon the slab. We may therefore conclude that in the surface skin on the average $t > p$, and the skin to the left of R will exert a net pull upon the skin to the right equal per unit length to

$$T = \int_0^h (t-p) dx.$$

T is the "surface tension."

This argument involves no assumption of any special mechanism or arrangement of molecules on the surface; such an arrangement, different from the state of the interior, may exist, as a separate phenomenon, or it may not. The argument does, however, lose most of its meaning if one adopts the modern idea that h is really very short, perhaps less than a molecular diameter. The difficulty is not to conceive how the state of tension can exist, but to show from molecular behaviour that it *must* exist. The surface must be a kinetic affair, with large momentary fluctuations of form and of molecular concentration, so that tension and pressure become mere statistical averages. Perhaps nothing more is possible for the theorist than to fall back on physical instead of molecular considerations, and to conclude from these that the dance of the surface molecules is so ordered as to make the mean horizontal tension exceed the mean pressure.

E. H. KENNARD.

Cornell University,
Ithaca, New York.

THE water drop hanging below an orifice takes up such a shape that the relation between the pressure difference p inside and outside the surface, the potential energy per unit area of the surface γ , and the radii of curvature of the surface R_1 and R_2 , is

$$p = \gamma \left(\frac{1}{R_1} + \frac{1}{R_2} \right).$$

This relation is deduced simply from the fact of potential energy in the surface proportional to its area, and holds good whatever the law of force or mechanism by which this potential energy is produced (See, for example, Besant and Ramsey, "Hydrostatics," 6th ed., p. 192; Gibbs, "Equilibrium of Heterogeneous Substances," Works, vol. 1, p. 228.) It is sufficient to account for the equilibrium of the drop. The fluidity of the water allows it to attain the configuration of least potential energy very rapidly, and this will be such that the curvature at each horizontal section is exactly that necessary to give an internal pressure at the level of that section, equal to atmospheric pressure plus the pressure due to the column of water above that section. Greater curvature will be necessary at the bottom of the drop than at the top. In my article in NATURE of April 4, I suggested that the greater internal pressure under a convex surface of liquid might be pictured as due to the convergence of the normals to the surface, drawn inwards, the attractive forces on molecules in the surface act along these normals. These inward forces are the cause of potential energy in the surface, since work must be done to form a new surface by dragging molecules from the interior. Since the relation between curvature and internal pressure can be deduced independently of the mechanism causing the surface potential energy, it is evident that the inward attractive forces on the surface molecules

can set up the pressure distribution within the drop which is consistent with minimum potential energy. No more is required to account for the equilibrium of the drop.

I think Dr Kennard is mistaken in his treatment of the statics of the problem. The molecules of water are moving across the plane P continually, so that any attempt to regard the drop merely as a piece of inert heavy baggage, which leads to the conclusion that it cannot be held up by cohesion in the centre, is not clear enough to give a solution. It does not help, when meeting the difficulties arising from this point of view, to ascribe the support of the drop to a hypothetical surface skin, about the properties of which nothing is stated. The consideration of the pressures at different levels in the drop at once gives the solution, as it so often does in hydrostatical problems. The motion of the particles of the drop, including exchange between surface and interior, is so rapid that it is not possible to ascribe the supporting of the weight of the drop to any particular region, and the method of pressures appears the only one available.

Dr Kennard's expression for the "tension" deduced from Laplace's theory seems quite sound as an expression for the average deficiency in internal pressure in the surface layer. But I can see no reason for calling this a tension. It might be properly termed a state of rarefaction. A rather similar argument was, I think, employed by Worthington (*Phil Mag*, 1884—I am without means of verifying the reference), who considered that there was probably a deficiency in density near the surface, and therefore there must be a tension in the surface to separate the molecules. Such arguments as these seem to be inspired more by the desire to employ the word "tension," with as many as possible of its associations, in connexion with the surface, than by any clear picture of what really is the structure in the surface.

There are other reasons than Laplace's theory for not regarding the surface as containing any material structure like a contractile skin. I have found three of these particularly convincing. Following Langmuir, in the attempt to unravel the structure of thin surface films, I found that it led nowhere to speculate how the fatty acid molecules acted on the surface skin so as to diminish its "strength." But regarding the molecules of the fatty acid film simply as hard floating objects, attracted by the water perpendicularly to the surface, attracting each other laterally, and small enough to show Brownian movement, very complete analogies have been drawn between these films and matter in three dimensions; and the shapes of the molecules have been shown to be exactly what would be expected from their structural formulæ, obtained by the methods of organic chemistry. It would be scarcely possible to find a stronger *a posteriori* argument against the existence of a contractile skin than this success obtained by its total abandonment.

Osborne Reynolds found that the motion of oil spreading on a dust-covered surface of water suggests strongly that the oil is spreading by reason of an inherent expansive force, and does not resemble at all that to be expected if the oil were being pulled out by the tension of a skin on the water. He was considerably puzzled by this, as he felt bound to consider the expansion of the oil as due to the tension of the water surface (Works, vol. 1, p. 410, Brit. Assoc. Rep., 1881).

Maxwell (Works, vol. 2, p. 553; "Ency. Brit." art. on Capillarity) considered what would occur if the surface tension between two liquids became

negative, concluding that in this case we should expect the interface to extend itself spontaneously, by folding and puckering. He pointed out that liquids do actually mix by diffusion, which is molecular motion. Some such puckering of the interface seems to be a necessary consequence of a "contractile skin" becoming negative in tension and becoming an expanding skin. No genuine case of mixing of liquids in this manner seems to be known; with Mr. Jessop I have recently examined what was reported as a case, but found it due to a peculiar combination of gravity and diffusion, only possible in very special circumstances, and not connected with capillary phenomena (Proc. Roy. Soc. A, 108, 324).

Regarded solely as a convenient mathematical equivalent for the potential energy associated with unit area of the surface, the term surface tension avoids constant reference to the principle of virtual work, and shortens calculations, but as a means of gaining insight into the molecular structure of surfaces, there is evidence that it has proved very misleading.

N. K. ADAM.

The University, Sheffield,
September 2.

The Miller Effect and Relativity.

It is reasonable that the unexpected results of the recent repetition of the Michelson experiment by Prof. D. C. Miller should have made Dr Silberstein say that they "knock out the relativity theory radically" (NATURE, May 23, p. 798). But though Einstein has built the special Theory of Relativity on the negative result of the experiment, I am of opinion that the Miller effect does not prove anything against the general theory. It should be stated emphatically that the *special Theory of Relativity can only be built up rigorously if based upon the general theory*, not inversely. The special theory does not consider any but linear transformations. But avoiding every acceleration implies the impossibility of comparing measures and clocks moving relatively to each other. On the other hand, the usual supposition that the effect of a passage from rest to uniform motion, etc., tends to zero with the time in which it takes place, can only be based upon the assumption that the ratio of the time to the proper time (interval) between two points on any (curved) world line remains finite and different from zero. But this assumption requires the consideration of non-linear transformations, and thus of the general Theory of Relativity.

In order to put the so-called "Principle of Equivalence" into a slightly different form, we make the following statements:

1. The world can be considered as a set of points which represent "event-particles."
2. The points can be ordered along "world lines" by means of a "relation of identity," which is given by the psychical phenomenon of recognition.
3. A bundle of world lines can be considered as a single world line. This is based upon the psychical judgement that they "belong together." This "relation of whole and parts" ("relation of class") permits us to consider the set of world points as four-dimensional.
4. There are considered binary relations between different points, namely, "relations of cause and effect," which can be represented by the "lines of causality."

5. *It is possible to describe every physical phenomenon by using only the relations of coincidence, identity, class and causality.*

These assumptions imply that we can construct a four-dimensional "graph" of universal history, graphs topologically equivalent not being distinguished by this definition. The very meaning of the ether-question is: Do the phenomena require a particular *metrical* system to which the universe must be referred? The reduction of the question to this form enables us to answer it at once, and obviously in the negative. For a topological transformation never can translate a "true" description of an observation into a "false" one. Relativistic physics has acquainted us with the new notion of the "metrical field" which is *apt to replace the old ether* as a carrier of electro-magnetic waves, so that it appears to be quite appropriate to reconcile "etherists" and "non-etherists."

Following a remark of Hermann Weyl ("Was ist Materie?", Berlin, Jul. Springer, 1924, p. 63) it is possible to reduce to rest simultaneously all bodies in the world (however they are moving relatively to each other) by means of a topological transformation. Consequently there is no meaning in speaking even about relative motion of separate bodies, e.g. of the stars and the earth. All we can say is that the earth moves relatively to the surrounding field, to the "star-compass." Here I would remark that even a relative motion of the earth to the surrounding field only has a meaning if the world is anisotropic around the earth: for a *spacial isotropic field can always be considered as being statical*.

The Miller effect shows us that rigid rotation does not leave the light-paths invariant; in other words, *that isotropy of the field and isotropy of the light-paths are not equivalent*. If rigid motion, that is to say, the *metric field*, is isotropic, then light-motion is not, and vice versa. Consequently the light-paths do not coincide with the minimal lines of the field. Although the Theory of Relativity in its present form holds for this coincidence, relativism in general leaves open the possibility of light-motion differing from quickest motion (as has been stated by Prof. Whitehead). Light only loses its exceptional qualities and quickest motion becomes an unreachable or at least unreachd limit, not only for material, but also for electro-magnetic motion, and in general for each form of motion which transports energy. But instead of being contradictory to the idea of relativism, this difference on the contrary agrees much better than the special Theory of Relativity with the modern view that matter and light are only gradually differing forms of energy.

Until now it has been impossible to say whether the Miller effect is due to translational or to rotational motion. In the first case the effect should vary periodically in time with the two periods of one day and one year, in the second case it should remain constant. From the point of view of the field-theory of matter the second case would mean a statical anisotropy of the field, whereas the first case would lead to an anisotropy varying in time, namely, a turning around the world lines of terrestrial matter, the latter being supposed to be reduced to rest.

In any case the Miller effect has shown us (according to a remark of Prof. G. Mannoury) that *the field, or the ether, or empty space, whichever you call it, plays an integrant part among the causal relations of physical phenomena and thus is not so very "empty" as it is supposed to be*.

D. VAN DANTZIG.

Westeinde 5,
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August 28.

Non-reversible Transmission.

ATTENTION has been directed to the possibility of non-reciprocal relations in the transmission of radio waves between two wireless stations (NATURE, by Prof. E. V. Appleton and M. A. F. Barnett, March 7, p. 333, 1925). Such a possibility appears at first sight to be contradicted by the general reciprocal theorem which states that the E.M.F. induced in A by unit current in B is equal to the E.M.F. induced in B by unit current in A . But this theorem rests on the assumption that all solutions are linear, and if this condition is waived, non-reciprocal relations are possible.

In confirmation of this the following examples may be cited which may have some bearing on the observed fact that transmission from west to east (on long waves at night), for example, England to Australia, appears to be considerably better than in the opposite direction. It should be noted that each of these are examples of "non-linear" effects. In the first case, consider a slab of ionised gas, the ionisation being assumed to be maintained by some external agency, for example, ultra-violet or X-rays. It can be shown that associated with this medium there is a critical frequency given by

$$n_0 = \left(\frac{e^2 N}{\pi m} \right)^{\frac{1}{2}}$$

where N = number of ions per c.c. (assumed for simplicity of one sign), e the charge, and m the mass of such ion. Neglecting the effect of collisions, then for frequencies n_0 the medium is transparent, but for frequencies less than n_0 the slab acts as a perfect reflector even for normal incidence. The physical reason for this is closely associated with the radiation pressure exerted by the electromagnetic waves on the medium. Thus in the neighbourhood of n_0 the rate of increase of momentum of the ions (due to the E.M. forces in the wave) is equal to the rate of change of momentum in the waves, where these are supposed to be completely reflected, so that the wave is totally reflected by mechanical reaction against the moving ions.

Consider now two radio stations A and B , one on each side of the slab. If the frequency of the emitted waves is n_0 or less than n_0 , neither station will be able to communicate with the other.

Now suppose the slab of ionised gas to be moving from left to right with a velocity v . So far as the slab is concerned, the frequency of the waves emitted by B will appear to be increased and those by A decreased. The slab will be transparent to waves from B but not to those from A , that is, B will be able to communicate with A , but A will not be able to communicate with B . Alternatively, we may treat the problem as an exercise in relativity with the same ultimate result.

The other example is more complex and depends upon the existence of a steady magnetic field.

A slab of ionised gas is again the mechanism by which the irreversible effects are produced. But in this case we assume that the ions have a velocity of drift, say vertically downwards (in the direction of the Z axis), that the normal to the electric wave is in the direction of the X axis, say right and left, and that the steady magnetic field, H_y , is at right angles to both, that is, in the y direction.

Under these conditions the electrons in the downward stream will be subject to two average forces, (a) a force at right angles to their velocity, and at right angles to the steady magnetic field H_y (this force will be in the X direction), and (b) a force due to the radiation pressure of the wave in the positive or negative direction according as the wave is moving

from left to right or vice versa. In the former case the two forces conspire in producing a motion in the ions, and in the latter, if H_y , V , and E are suitably arranged, they cancel. The reaction of the ions on the incoming wave will then be different according as the wave moves from left to right or vice versa. In the latter case there should be no work done by the radiation pressure on the ions, and therefore no loss of energy in the waves, in the former case work is done and a consequent loss of energy ensues.

The amount of reflection will be different according as the wave approaches from the left or from the right, and an irreversible effect is produced.

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The Future of the British Patent Office.

DR MARTIN'S courteous letter in NATURE of September 12 calls for some reply, for although on questions of history we are in the main in agreement, yet when, as he says, we come to close quarters, he fails to reproduce my argument quite accurately.

Dr. Martin says, for example, that my two basic principles are not necessarily antagonistic. This I asserted, but said that for administrative purposes they could not be treated as co-equal, for the two types of administration would differ fundamentally. If the institution of new industries is the proposed object of our patent law, as I think is clearly the case from the provisions in the 1919 Act, the application form would have to be altered. The applicant would be required to affirm, as he used to do, that he was in possession of an invention which was not in use in the kingdom, and which it was his intention to introduce at the earliest opportunity. The official search certificate would state to what extent, if at all, the applicant's claims appeared to conflict with descriptions or claims in British specification of patents in force or with pending applications of concurrent or prior date. The case of applications under the International Convention would have to be reconsidered. The preferential treatment of the foreigner has always seemed to me contrary to the policy of our patent law. The validity of patents when granted would depend—(a) in cases where commercial working was shown, upon the state of the art in the kingdom at the date of the letters patent, and (b) where the patentee relied upon his specification, upon the state of public knowledge in the kingdom. In the latter case the patentee would be bound to show good reason why his patent had not been put into practice.

It is not, therefore, correct to say that since perfection in practice cannot be attained I recommend no search at all. My view is that, where one inventor fails, others should be encouraged to try again. For this purpose the official search must be brought into harmony with the revised statutory definition of novelty.

The anonymous letter which I quoted was intended to show that the world-wide search was breaking down and that, in the opinion of one well informed in American practice, a radical change in the statutory definition of novelty was the only solution of the difficulty. All bibliographical evidence tends to support his opinion.

Again, Dr. Martin does not agree with the thesis "that when security is at its highest, restraining power is necessarily at its lowest"—but my statement was "that as a general rule when security is at its highest the other factor will be little or none at all." The percentage, however, of really great inventions which pass scathless through the fire of the examining staff

is very small, and their commercial value depends, not upon an examiner's report, but upon the homage paid by all men of science to the path-breaker who opens a new road of research for the benefit of mankind.

E. WYNDHAM HULME.

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THE present Patent Office search, extending back for fifty years for novelty, is, as Mr Hulme says (NATURE, September 5, p. 356), really useless, and a fuller search ridiculous. To the inventor it is irritating; and it is of little value to the manufacturer, for before he gives a high price for the monopoly or spends much in adapting his plant and designs for using it, he, as a prudent man, will want something more.

Of course the granting of letters patent for overlapping existing protected inventions should be avoided, but that is all that is required. It should be open to any one to use the invention, or part of it, if he can show that it, or the part of it he is using, is old in the sense that it has actually been used; and a patent should not be invalidated because it, or part of it, has been described or figured a long time ago and forgotten until rediscovered by much "fever of the brow" and expenditure of time of the searchers.

TRAVERS J. BRIANT

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Analysis of the Arc Spectrum of Copper.

STARTING from the constant frequency differences in the copper arc-spectrum, suggested by Rydberg, I have recently been able to deduce the values of a large number of new terms of that spectrum. My paper in the *Philosophical Magazine* (vol. 69, p. 951) has shown that copper gives a spectrum which is far from simple, and the further data now obtained show even greater complexity.

The new terms can be divided into two sets, those of the first set all being positive and combining with one or both of the known abnormally high d -terms. This set contains several terms already used in my paper. The inner quantum numbers are of course definite except in those cases where combinations with both d_2 and d_3 occur. The second set of terms consists altogether of negative terms which each combine with three or more of the first positive set, giving lines the wave-numbers of which differ from the calculated by not more than two-tenths of a wave-number. Altogether, about 125 lines are accounted for by these new terms. The inner quantum numbers of the negative terms can be deduced, though with some uncertainty, from their combinations with the positive terms. The values of the terms are as follows, the probable nature and inner quantum numbers being given with each

5026 2 ($j=4$)	- 95 2 (3)
5656 7 (2 or 3)	- 640 2 (p'_3)
6278 2 (4)	- 1276 4 (p'_1)
15709 8 (2 or 3)	- 8690 0 (3)
17345 2 (4)	- 8819 7 (3)
17763 9 (p_2)	- 8870 1 (3)
17901 8 (d'_3)	- 8960 1 (3)
18581 9 (d'_2)	- 9619 1 (p'_2)
18794 1 (4)	- 9708 6 (3)
20005 5 (s'_1)	- 9758 9 (p'_2)
20745 2 (2)	- 9785 0 (3)
21154 7 (4)	- 10890 7 (p'_2)
21364 3 (p_1)	- 10996 5 (p'_2)
22194 0 (p_2)	- 14722 0 (5)
23289 4 (4)	- 14760 1 (5)

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As yet I have been unable definitely to arrange many of these terms together either as doublets or quartets. It is evident, however, that quartets are involved. The difficulty arises partly from the large separations which are common in the copper spectrum and make estimations of relative intensities of lines of a multiplet uncertain. The complete analysis should afford tests of the theory of negative terms suggested by Russell and Saunders in their recent paper on the calcium spectrum.

Dr. L. A. Turner, of Harvard University, has recently suggested to me a possible explanation of the abnormally large inverted d -terms in the copper spectrum 51105 5 (d_3) and 49062 6 (d_2), based on considerations brought out in a paper by Pauli (*Zeit für Phys.* 31, 10). If we consider these terms as being due to the displacement of an electron from a 3_{32} or a 3_{33} group to the 4_{11} group, which is then closed, the atom might be considered as in a d -state. The inversion would be accounted for since the 3_{33} position is of higher energy than the 3_{32} position. Moreover, the formula $\Delta\nu/R = (z-s)^{1/2} a^2/3^4$ (Sommerfeld, p. 449) should yield a screening constant s approximately equal to 13.0, which is the value given by the separation of M_{32} and M_{33} for atoms of high atomic number. The value found is $s = 13.6$, which is suggestively close, considering the large extrapolation, and the approximation involved in considering the two electrons in the 4_{11} ring as having the same effect in the two cases.

A. G. SHENSTONE.

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August 3.

Dispersal of Butterflies and other Insects.

IN the issue of NATURE for September 5, Mr. E. P. Felt in his interesting article on the "Dispersal of Butterflies and other Insects" says, "It is quite possible that some insect movements are direct responses to a migration impulse." As bearing on this point, the following incident, which occurred some years ago, may not be without interest.

I was walking through a field of standing wheat that was growing on the Downs near Walmer, Kent, the sun was just below the horizon, the air warm and still, when I noticed that moths were rising from the wheat and flying vertically upwards until they were lost to sight. On closer inspection, I found that vast numbers of the silver Y moth (*Plusia gamma*) were buzzing about among the wheat stems and that individuals were continually leaving their fellows and taking the upward flight. Although the larva of *P. gamma* will feed upon a great variety of low-growing plants, such as nettles, docks, and so forth, it is most unlikely that such numbers could have found sustenance on the weeds that might be growing in a fairly well kept wheat field, and the inference is that the moths had assembled among the wheat stems with the purpose of migration, and by their upward flight were seeking a favourable wind current to assist them in their journeyings in the upper air.

The incident, moreover, is not an isolated one, for Richard South describes a similar happening (*Entomologist*, 1880, p. 42) which he had witnessed in the Isle of Wight: the insects were, he believes, the same species, but in his case they were rising from furze bushes.

ROBERT ADKIN

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Fifty Years' Evolution in Naval Architecture and Marine Engineering.¹

By Sir ARCHIBALD DENNY, Bart.

AFTER Watt's invention of the separate condenser, many years elapsed before the next considerable step in marine engineering—the introduction of the compound steam-engine. This was natural, as steam pressures were too low to make compounding profitable. The first record I can find of compounding was John Elder's *Brandon* in 1854, and progress thereafter was not very rapid; but when I began my apprenticeship, in 1876, the old box boiler had been replaced by the now highly appreciated Scotch circular return-tube boiler, supplying steam to two-cylinder compound engines at about 60-lb. pressure. It was not then found profitable to carry more than about 25 in. of vacuum. Auxiliary machinery was almost non-existent.

As to types of marine engines—in the Navy, for protection reasons, horizontal machinery was not uncommon, while in the mercantile marine, for screw ships, the vertical type was practically universal. In paddle-steamers for river and coast service, of which there were many, the beautiful oscillating engine, which had the advantage of taking up little room lengthwise, was still built; but the diagonal engine was more common, either with single cylinder and haystack boiler or compound two-cylinder.

Returning to sea-going vessels, the *Propontis*, a vessel built in 1864, was re-engined at Fairfield with triple-expansion three-crank engines designed by the late Dr. Kirk in 1874, with boilers working at 150-lb. pressure; but the boilers, Rowan's water-tube, proved unsatisfactory, and in 1876 new Scotch boilers of 90-lb. pressure were fitted. The first really successful triple-expansion three-crank job, the *Aberdeen*,² was built in 1880 by Robert Napier and Sons, and fitted with engines and 125-lb. pressure boilers designed by Dr. Kirk. The re-engining of the *Propontis*, however, marked the opening of a new era, which only developed slowly at first, due in some measure to the then rules for the thickness of the boiler shells and furnaces.

The next great step was the introduction of the Parsons turbine. None can forget the tremendous interest created by the appearance of the 34½-knot 100-ft. *Turbinia*, at Spithead Review in 1897. I felt that here was the engine we had been looking for to use in fast cross-Channel work, and it was a great gratification when Sir Charles Parsons and Captain John Williamson arranged with my firm that we should join in a venture to build and run a Clyde river-steamer fitted with turbines; the *King Edward*, put on service in the spring of 1901, was the result—the first commercial turbine. Before that, however, in 1898, the Parsons Marine Steam Turbine Company received an order from the Admiralty to build the *Viper*, and Messrs. Armstrong, Whitworth, on their own account, built the *Cobra*, engined by Parsons. Both of these were torpedo-boat destroyers, and the *Cobra* was purchased by the Admiralty.

Following the *King Edward* and *Queen Alexandra*,

the *Queen* for the Dover-Calais service and the *Brighton* for the Newhaven-Dieppe service were the first cross-Channel turbine steamers put in service in 1903. They also were most successful, and the turbine as a commercial engine was fairly launched, a great tribute to the genius of Sir Charles Parsons and his courage in overcoming the many initial difficulties. The decision, taken early in 1905, to fit turbines in the large Cunarders *Lusitania* and *Mauretania*, built by Messrs. John Brown and Messrs. Swan and Hunter respectively, was a very bold and momentous one fully justified by the success of these vessels; it was a tremendous step to take from the smaller vessels already built and tried, to these leviathans crossing the stormy Atlantic. In 1905 the Admiralty also decided on the general introduction of turbines in all classes of warships.

The earlier turbines were all fitted as direct drives and hence to vessels of fairly high speed, when the revolutions were not too low to spoil the efficiency of the turbine or so high as to spoil the efficiency of the propeller. But from the first it was felt that some means of gearing down the propellers was absolutely necessary; Sir Charles Parsons' conversion of the *Vespasian* in 1909 from reciprocating to geared turbine gave the answer required and marked another new era.

In 1897 Dr. Diesel began developing his internal-combustion engine, depending for the ignition of the charge of heavy oil not on electric sparks, hot tubes, or bulbs, but on the heat generated by compressing the air charge. Immense developments have taken place in this direction. Initially the greatest progress was made with this type of engine on the Continent. My information is that the first successful ocean-going motor-ship was the *Vulcanus*, built in 1911 by Werkspoor of Amsterdam for the Anglo-Saxon Petroleum Oil Co., while the first completed in Great Britain was the *Jutlandia*, built in 1912 by Barclay, Curle and Co.

While Great Britain may have been slow at first in taking up the Diesel, certain types—such, for example, as the Doxford and the Cammell Laird-Fullagar—are purely English. Another purely English one (which, being a combination of steam and oil, is exceptionally interesting) is the Still engine, of which that on the *Dolus*, built by Messrs. Scott of Greenock for Messrs. Alfred Holt and Co. of Liverpool, has been successful. The first double-acting four-stroke cycle marine engine in Great Britain was developed at the North-Eastern Marine.

While the turbine developed from the fast passenger-vessels direct driven, to the slow cargo-boat with gearing, the Diesel started in the slow cargo-vessel and is developing towards the faster liner, of which the *Aorangi* of the Union Steamship Co. of New Zealand, built this year by the Fairfield Co., is, at the time I am writing, the most notable example.

The foregoing is the briefest of brief outlines of the changes in the main engines of ships, but the development in auxiliary machinery has been of tremendous importance and extent. In no direction has advance been greater than in the use of electricity on board

¹ From the presidential address delivered at Southampton on August 27 before Section G (Engineering) of the British Association.

² Messrs. Augustine Normand, Havre, have now proved to me that Benjamin Normand fitted a Seine passenger steamer with triple-expansion engines in 1871, and fitted at least two more successfully before 1874.

ship. In 1884 the *Arawa* and *Tanui* were fitted with incandescent electric lighting with stand-by oil lamps. The total power used was about 30 horse.

What developments there have been since then! Instead of the feeble 20 kilowatts, hundreds of kilowatts are now in use on a vessel of the same size, and the current is used not only for lighting, but also for ventilating, local heating, cooking, and for driving small machinery of all kinds, including frequently many of the important engine-room auxiliaries; in fact, in some vessels practically all the auxiliaries are driven by electric motors.

The fuel consumed in developing the power of these auxiliaries is now such an important proportion of the total fuel consumed that their design and installation is becoming, to a certain extent, a separate branch of engineering. To show the importance of a thorough study of this auxiliary-power question on board ship, I have been informed that in a large intermediate passenger-ship the consumption of fuel for auxiliaries is reported as exceeding 10 per cent. of the total consumption, and that 15 per cent. or more is not uncommon in some other vessels.

In types of boilers the development has gone from the old box form with safety valve opening inwards to prevent them collapsing when cooling, to the well-known and most extensively used Scotch marine circular boiler with return tubes. But always there were inventors working at the water-tube boiler, and several were constructed which proved successful. The Haystack was an early example, and those of Yarrow, of Thornycroft, and of Babcock and Wilcox may be named as types. In my own experience Yarrow and Babcock have each been used in fast cross-Channel steamers with absolute success, and, apart from the great user of water-tube boilers, the Royal Navy, water-tube boilers are being used increasingly in oversea merchant-ships. For land stations they are in great demand, fitted with mechanical coal-stokers or with pulverised coal or oil firing, in units of such enormous size and with steam pressure so high that steam drums have been built and used 34 ft. long, 4 ft. internal diameter, and 4 in. thick. Shall we see such boilers on board merchant-ships? I have no doubt we shall, though I would not care to express any opinion as to the ultimate highest steam-pressure which will be used, but 500 lb. is in sight.

Superheating of steam was early recognised as a very desirable thing, but it took many years to produce a reliable superheater, and then there were lubrication and other difficulties in reciprocating engines which had to be surmounted. In the case of turbines certain of these difficulties were non-existent, and turbines are peculiarly suited to the use of superheated steam. Another economical advance is pre-heating of air, which is now being pushed much further than ever, but with which the name of Howden will always be associated. Stage feed-water heating is also being very fully carried out.

Fuel-oil firing of boilers has been very largely adopted in steamships, with a marked gain in speed and, when oil is marketed at certain figures, with economy of cost as compared with coal, not only on account of its relatively smaller weight consumption, but also on account of the reduced crew required and the more regular

speed obtained, hence shorter time at sea. But in considering the relative advantages of steam- and motor-driven ships one must remember that an oil-fired steamship, in the event of oil soaring in price, may be converted to coal-burning, while in a motor-ship the owner has not that option.

As to powers developed by the main engines in any one steamship, from the 2000-3000 I.H.P. in good class passenger-ships of 1875 to the 75,000 I.H.P. we now find in the most powerful merchant-ships, or more than 140,000 in naval vessels, is a stupendous step.

Turning now to the ship herself and to naval architecture. I crossed to the United States to see ships' behaviour in heavy weather in December of 1882 in the *Parisian*, of the Allan Line, and returned in the same month by the *Alaska*. The latter was the "crack ship" at that time, and was 500 ft. long, the former was 440 ft. long, and they were considered enormous ships. The *City of Rome* was 560 ft., but was not so fast as the *Alaska*. They were all single-screw ships.

Mr. Foster King read a paper at Philadelphia, U.S.A., in 1912, in which he divided ships into three groups:

- (a) Atlantic passenger-ships (the longest ships).
- (b) Passenger-ships on all other routes.
- (c) Cargo-ships.

He obtained from the owners and registry books particulars of thousands of ships, and plotted them on diagrams on a base of years and with lengths of ships as ordinates. From these diagrams he concluded that the growth of "the largest ships in the world" might be fairly represented by straight lines in each group; that group (a) ships grew at the rate of 66 ft. in ten years, and group (b) 50 ft. in ten years. He observed, however, that after 1897 special vessels in (a)—namely, the fast Atlantic ferry—grew much more rapidly, at the rate of 150 ft. in ten years. For cargo-vessels (c) the rate of growth was about 30 ft. in ten years.

Taking Mr. King's (a) line, in 1875 the longest ship was about 475 ft., while, owing to the above-mentioned offshoot of the Atlantic ferry-boats, in 1912 it was round 900 ft. The *Majestic*, the present longest ship, is 915.5 ft. Reading from the (b) line, in 1875 the longest ship was round about 425 ft. In 1912 it should have been 610 ft., but was actually 570, and he remarks in explanation that "one of the usual pauses was occurring." The *Oronsay*, on the Australian trade, is the present longest (b) line boat at 633.6 ft. The *Empress of Canada*, on the Pacific, is 627 ft. long. As to cargo-ships—general traders—in 1875 a 3000 dead-weight carrier was a large ship; the more usual size was 2000-2500 tons. Now, 7000 to 8000 is the ordinary size, 10,000 is not uncommon, and many exceed that latter dead-weight.

In dealing with the growth in breadth of ships, Mr. King remarks that about 1875 the fashion in passenger-ships was about ten beams to length, but that after 1880 proportionate breadth became rapidly greater. An analysis of data available to me confirms this view, and that it is not now uncommon to find a proportion of eight beams to length, or even seven and a half.

The draught increased along with the increase in length, and the ports were constantly improved in depth, while new dry docks and floating docks kept

pace. Perhaps no better example can be given than the port of Southampton with its "longest in the world" floating dock.

Increase in draught is usually the most economical way of increasing carrying capacity or speed, hence the desire of naval architects for ample depth in ports and canals. When a curve of draught for the same proportion of depth to length is drawn with length as a base, it is seen at once that draught is proportionately less for the longer ship, and, as Lloyd's original tables were based on the current practice of the day, it is to be presumed that practical sea experience is responsible for this. Mr. Foster King's 1912 analysis of practice, as might be expected, shows the same thing. In the early 'eighties, however, experience was limited to about 400 ft. in length, and subsequent experience has shown that these and the longer steamers might safely be loaded deeper than the original rules contemplated.

Let us now turn to consider the change in the provisions for the comfort and convenience of the passenger. In the earlier days of steamships the first-class were in a poop, and the accommodation was very much in the style of the old sailing-ship—a row of cabins at each side with the dining-tables in the centre. There was an open-ended bridge and a fore-castle, where the officers and men were accommodated. Gradually, in later vessels the poop joined the bridge, and then the bridge joined the fore-castle, and the vessels became awning-deckers or spar-deckers. Then in later ships fore-castles again appeared, and midship houses developed into bridge-houses; then poops were fitted, to go once more through the same programme. Thus, as size increased, deck after deck has been added, until in the largest vessels the old names of bridge, upper, main, lower, and orlop no longer suffice, nor are they truly descriptive, and the decks are lettered A, B, C, D, etc.

The navigating bridge of a modern high-class steamer is an inspiring sight, with gyro compass probably fitted with an automatic quartermaster, "tell-tales" from the engine-room giving the revolutions of the engine and the direction of turning, similar "tell-tales" to the rudder head showing the angle of the tiller; the steering gear, now fitted aft, is controlled by a "telemotor," first invented by A. B. Brown of Edinburgh; wireless rooms, wireless direction-finder, and it may be underwater microphones for finding the position from underwater land bells; probably an outfit of telephones communicating from the bridge to the various chiefs of departments; automatic indicators showing the water in all holds and ballast tanks, and means for closing all watertight doors below deck in event of fog or collision.

Returning for a moment to the cargo-steamer—I have already dealt with the growth in size, but there are many other changes in these ships. Sails having practically disappeared, we find the place of masts taken by Samson posts and gantries; indeed, very many modern vessels, built for special trades, look more like a building berth in a shipyard than a sea-going steamer. The equipment has much improved both in the engine-room and on deck, and cargo appliances are quite different. But an important change is in the question of fullness of

block. For a considerable time the shipowner seemed to think in terms of £'s per ton dead-weight. This inevitably led to fuller and fuller blocks, until 0.83 was not uncommon; result—a low speed and a great uncertainty as to date of arrival at a port if any bad weather was encountered. Of course, block must be coupled with length, for the longer ship may have a fuller block, but round 400 ft. a block of 0.76 is now much more fashionable, with the result that, while the dead-weight lifted at one time on the same length of vessel is less, yet the higher speed and the greater regularity of time on the voyage, due to the ability to keep up a reasonable speed in bad weather, make the finer vessel a more economic proposition.

A most interesting and important type of special trader is the bulk-oil carrier or oil-tanker, which has developed quite a special technique in design, construction, and fastenings. Originally oil was carried in cases, but, starting with quite small bulk-oil carriers, we now find oil-tankers among the mammoth dead-weight carriers of to-day. Bulk grain, coal, and especially ore carriers, involve also quite special considerations in stability, and strength to resist concentrated loads in the last mentioned, of which type the highest development is to be seen on the Great Lakes of North America.

I have not referred at all to the tremendous changes which have taken place in the Royal Navy; that in itself would take more time than I have at my disposal. In main engines, however, the lines of development have been much the same as in the mercantile marine, while in the vessels themselves their purpose is so different that no comparisons can be drawn. But their design has not been without its influence on the merchant-ship in many details, and there are several directions in which the work at the Admiralty has had a commanding influence on naval architecture in Great Britain.

We may now turn to the technical training of the marine engineer and naval architect. Until the founding of the John Elder chair of naval architecture and marine engineering at the University of Glasgow, the technical education available to apprentices in private works was provided practically entirely by evening classes under the South Kensington Science and Art Department. Many of those men who, for at least a generation, were responsible for the great strides made in the technical efficiency of the twin industries received their professional education at these classes. These classes are still doing good work. Of course even before special chairs were established, B.Sc. courses in engineering were open to students, but only a few bursary or moneyed students could take advantage of them. For generations the Royal dockyards have taken care of the technical instruction of their apprentices, and schools for their instruction were, and are, at work in every dockyard. I can only stop to note the foundation of the Royal School of Naval Architecture and Marine Engineering at South Kensington. The best students from each dockyard were sent there for the first time in 1864, to receive a training in higher science and mathematics of a severity unmatched in any college.

Without proper technical education an efficient corps of designers and of research workers could not be main-

tained, and considerable and important has been the research work guided by the Admiralty, by our technical institutions, by Lloyd's Registry, and by many private firms and individuals.

In research, to no two men are we more indebted than to Dr. Wm. Froude and his son, Mr. R. E. Froude, for the experimental work done by them on ships' resistance and screw propellers. The British Association in 1868 appointed a committee to consider stability, propulsion, and sea-going qualities of ships, and of that committee Dr. Froude was a member, the others being Merrifield, Galton, and Rankine. The committee recommended experiments on actual ships, but Dr. Froude dissented and gave it as his opinion that model experiments were of value and were much cheaper to carry out, describing some he had made in 1867. In 1868-69, on the suggestion of Sir Edward Reed, then Chief Constructor, the Admiralty agreed to bear the cost of the construction and the working costs of the tank at Chelston Cross, Torquay. This tank started work in 1871, Dr. Froude acting as chief, and he gave his services gratuitously as long as he lived. On his death Mr. R. E. Froude took over charge, continuing and expanding his father's work. The results were freely communicated by him, with the full consent and encouragement of the Admiralty, to the Institution of Naval Architects in a series of valuable papers. The Torquay tank was ultimately dismantled and transferred to Haslar, where the good work is continuing.

There are now, besides the Government tank at Haslar, the following Froude tanks in Great Britain, in the order of age—Denny (Dumbarton), Brown (Clydebank), William Froude (Teddington), Vickers (St. Albans), and Parsons' have also a smaller open-air tank at Newcastle: that is six; and there are in Italy, Germany, France, Sweden, Russia, Austria, Japan, and the United States other eleven, a total of seventeen, and it may be claimed that tanks have had more far-reaching effect on design than any other means of research.

Yet, when one considers the research carried out on ferrous and non-ferrous metals, that claim may be disputed. Time fails me to do more than indicate to you the history of mild steel. While steel had been used in shipbuilding at an earlier date, our present material came into daily use in merchant-ship building in the late seventies of last century, and I can remember the interest taken in the *Buenos Ayrean*, the first steel Atlantic ship, built in 1879. With the considerable reduction in scantlings allowed by the Classification Societies, mild steel rapidly displaced iron in ship construction. But still we were warned that it was unreliable if worked at a blue heat, and some failures were recorded. Further improvement in manufacturing methods, however, finally gave us a material of great reliability and easily worked. The limits of 28-32 tensile strength and 20 per cent. extension in an 8-inch specimen have been standard now for many years, though steels of greater carbon content and higher tensile strength have been used: and as Young's modulus is practically the same for all ordinary carbon steels, these higher tensile steels could be used in conjunction with milder steels without disadvantage. But there is now another mild carbon steel on the market which has a higher elastic limit, the use of which

is just beginning; it is claimed that it will ensure further advantageous developments in reduction of weight of hull.

Sir Robert Hadfield's invention of high-manganese steel gave a fresh impetus to research in ferrous alloys; and now we have alloys of nickel, chromium, vanadium, tungsten, and other metals, each with its own special use either in construction of ships and their machinery or in the machine-shop for tool-steel, thus still further advancing the science and art of shipbuilding and marine engineering.

Other powerful factors in the development of the merchant marine were the Board of Trade, the Classification Societies, and the technical institutions and societies.

The Board of Trade is charged by statute with the duty of seeing that ships are safe and sufficient for navigation. The individual surveyor is legally responsible, and it is he who must certify safety and sufficiency; but, for co-ordination purposes, there is a Consultative Branch at Whitehall which issues "Suggestions and Instructions" to the surveyors as to how they should carry out their duties. These "buff books" have in practice largely the same effect as the rules and regulations of the Classification Societies.

Practically every maritime nation has a Registry or Classification body or bodies of its own, but in Great Britain that type of organisation has been earlier and more fully developed than in other countries. Lloyd's Registry has a world-wide name and has had a profound influence on design not only in this country but also all over the world. This leads me to speak of standardisation in shipbuilding and engineering. The first work of the B.E.S.A., when it was established in 1901, was the standardising of ships' sectional material. Order was thus brought out of chaos, the number of standards, sections of all kinds and sizes, was fixed at 175, and the steelmakers reported that a saving of at least 5s. per ton was the result. A revision in 1918 reduced the standard sections to 115. A recent piece of work of the B.E.S.A. is the standardising of the tail-shafts of ordinary cargo-vessels, which standards may also be applicable to many passenger-ships. The taper of the shaft to take the propeller boss is also fixed. It can easily be seen what a saving this would mean in the case of damage at a distant out-port, where, were these standards adopted, only a few spares need be kept, or even the spare of one steamer could be used for another with the same diameter shaft, and thus in the case of damage the present long delays in an out-port waiting for replace parts would be avoided.

The influence of the Institution of Naval Architects on the progress of design cannot be exaggerated. Founded in 1860, there has been a constant stream of valuable papers read and discussed at the annual meetings; naval architects and marine engineers were glad of the opportunity of presenting the results of their experience to their fellows and of profiting by the discussion of their ideas. Now there are all over Great Britain—at Liverpool, Newcastle, Southampton, Glasgow, and other centres—similar institutions, contributing to the advance of the science by their meetings and published transactions.

Radiometric Determination of the Temperature of Mars in 1924.

By Dr. W. W. COBLENTZ, Bureau of Standards, Washington, D.C.

THE main problem in the radiometric programme of 1924 at the Lowell Observatory, as stated in the article in NATURE of September 19, p. 439, was the measurement of the radiation from Mars. For this purpose most of the measurements were made at the 640-inch focus of the 40-inch Lowell reflector, which gave an image of the disc of Mars about 2 mm. in diameter. The receiver of the vacuum thermocouple was 0.23 mm. in diameter, or about $\frac{1}{8}$ of the diameter of the disc of Mars at opposition. This permitted the isolation of small areas on the disk of the planet and revealed hitherto unobserved and perhaps unexpected temperature conditions.

By means of a series of screens of water, quartz, glass, and fluorite, the radiation emanating from a planet, e.g. Mars, was separated into spectral components and the radiation intensities determined in the

observed Martian water-cell transmissions (W.C.T.'s in Table 1); (2) by the law of spectral radiation and the ratio of the Martian spectral radiation components, A : B; (3) by plotting Very's observed lunar temperatures against the observed lunar spectral radiation components, A : B, and extrapolating to the observed ratios of the Martian components; (4) by calculating the lunar temperatures (Menzel) from the lunar water-cell transmissions, using the fourth power law, plotting these temperatures against the observed lunar spectral radiation components, A : B, and extrapolating to the observed ratios of the Martian spectral radiation components; and (5) by plotting the lunar temperatures (which were obtained by calculation from the lunar water-cell transmissions, using the fourth power law) against the observed lunar water-cell transmissions and extrapolating to the observed Martian water-cell trans-

TABLE 1.—MARS. COMPARISON OF TEMPERATURES ON THE APPARENT CENTRE OF THE DISK AS OBTAINED BY VARIOUS METHODS

Date 1924.	Water-cell Trans- mission (W.C.T.).	Spectral Com- ponents (A · B).	Temperatures, °C. Method.					Mean.	Region on Mars.
			Black Body.		Moon				
			1 Menzel (W.C.T.).	2 (A · B).	3 Very (A · B).	4 Menzel (A · B).	5 (W.C.T.).		
Aug 6	33·5	41·7	-1	12	14	12	2	8	Syrtis Major.
14	30·5	41·3	9	10	13	11	16	12	Mare Sirenum.
15	32·4	43·1	5	21	18	14	8	13	"
18	31·1	38·6	4	-5	8	7	13	6	"
21	32·5	40·7	3	6	12	10	6	7	"
21	34·9	39·1	-5	-3	6	8	-7	0	Bright region north of Mare Sirenum.
23	32·8	36·6	2	-20	3	4	4	-1	Bright " region " north " of Beak of Sirens.
25	33·7	38·3	-7	-8	7	6	2	-1	
28 Sept.	31·2	50·0 ?	4	55 ?	32	24	12	18	Solis Lacus. Poor seeing.
11	30·8	47·8	1	45	26	20	15	22	Syrtis Major.
13	29·6	39·3	6	-2	10	8	22	9	"
13	25·1	55·8 ?	22	..	42	32	..	32	" 18·4 foot focus
14	29·3	46·4	6	40	22	18	25	22	Mare Cimmerium.

spectral regions of 0.03 to 1.4 μ , 1.4 to 4.1 μ , 4.1 to 8 μ , 8 to 12.5 μ , and 12.5 to 15 μ . In this paper the ratios of the spectral components of the planetary radiation at 8 to 12.5 μ and at 12.5 to 15 μ (A : B) are of special interest. The radiometric work was carried out in collaboration with Mr. C. O. Lampland, and the complete results are given in the June and July issues of the Journal of the Franklin Institute.

In view of the conflicting opinions regarding temperature conditions on Mars, it was desirable to reduce the radiometric data by various methods and also to have someone not connected with the work to make some of the calculations. The writer therefore submitted to Dr. D. H. Menzel a considerable portion of the observations obtained in 1924 for calculation, thus supplementing the work of 1922, as mentioned in NATURE of September 19.

Martian temperatures were derived by the following methods: (1) by the fourth power law of black body radiation (Menzel), using Russell's formula and the

missions. (A more complete discussion is given in the *Astronomische Nachrichten*, June 1925.)

In addition to these calculations, planetary temperatures were inferred from comparisons with the earth, in which it is shown that the temperature of the solid surface of Mars would be expected to rise almost as high as that of the earth. In fact, with much clearer skies and with less air convection in some of the darker places on Mars, especially in the temperate and in the frigid zones, where the insolation is so prolonged, the temperature should be considerably higher than observed on similar regions of the earth.

The temperatures derived by these various methods of reducing the data are in good agreement and indicate conclusively that the equatorial temperature of Mars, at perihelion, was considerably above 0° C. When one considers the difficulty in establishing the temperature of a terrestrial object within 10° C., it seems truly remarkable that these various methods appear to be so close in agreement in indicating that the temperature

of Mars rises above 0°C . This is an extremely important deduction, for the possibility of vegetable life on Mars depends partly upon the question of temperature conditions.

A weakness in the method of using the spectral components is owing to the fact that the spectral range of the planetary radiation is narrow, and the spectral transmissions of the atmosphere and of the fluorite screen at 10 to 11μ are not known with sufficient accuracy to determine the temperatures to better than 10°C . However, it is a new and an independent method for obtaining temperature levels.

Ordinarily it would be considered sufficiently close to have determined the temperature level to within 10°C . However, in the present problem the temperature estimates range about 0°C ., and the question at issue is whether the average estimates place the value somewhat above 0°C ., for the question of the possibility of vegetation on Mars depends partly upon this temperature estimate. While the results obtained by this method give a wider range of temperatures than the other methods, its usefulness in supplementing the other methods seems evident.

The dark regions were found to be hotter than the bright regions; also the east limb or sunrise side was observed to be cooler than the west limb or afternoon side of the planet. The temperatures of the bright areas range from -10° to 5°C ., while the temperatures of the dark areas range from 10° to 20°C ., or perhaps even higher. The average temperature of the apparent centre of the disk, including the bright and the dark areas, was found to be about 15°C ., verifying the estimate of 10° to 20°C . based upon the radiometric measurements of 1922. There was but little seasonal change in temperature (average 14°C .) on the centre of the disk during the six weeks from August 1 to September 14. While the measurements were in progress it was winter in the north polar regions. Under these conditions the temperature of the irradiated north polar region was down to -70°C ., or perhaps even lower, and continued at this temperature during the course of our measurements. Similar temperatures occur in our arctic regions during the winter. On the southern hemisphere it was early summer, and the temperature of the south polar region, as observed through the overhanging atmospheric mantle of mist or perhaps ice spicules, was -60°C . However, in view of the fact that it was the summer season, with melting snow and a receding polar cap, it is reasonable to assume that the temperature of the solid surface at the south pole was up to 0°C . The complete paper by Coblentz and Lampland in the Jour. Franklin Institute (June and July 1925) gives data on climatic conditions on various parts of the surface of Mars: (1) the bright and dark regions on the centre of the disk; (2) the east and west limbs; and (3) the north and south polar regions.

To the writer the apparent temperature of -60°C ., as measured through the water cell during the early Martian summer in the south polar region, is not inconsistent with the commonsense interpretation of the visual observations (receding polar cap, melting ice) indicating a temperature up to 0°C ., but is a remarkable verification of the presence of an atmosphere containing a mantle of ice spicules or perhaps water vapour

("mist"), which prevents the escape of planetary radiation from the solid surface. It is to be noted that our interpretation of planetary temperatures is based upon the radiation of wave-lengths 8 to 15μ which emanates from the planet. Evidently this overhanging mantle is of considerable extent and is perhaps in the form of a thick mist or fog which is opaque to these wave-lengths. For it is well known that the highly attenuated water vapour in our atmosphere is quite transparent to radiation of wave-lengths 8 to 15μ , whereas mist and fog prevent the transmission of infra-red rays of long wave-length.

The temperature of the south polar cap changed but slowly during July and August. However, in September the temperature began to rise rapidly, and by October the water-cell transmissions decreased to 30 per cent. or even lower, indicating a temperature of 6°C (true temperature about 15°C .). This is extremely interesting in view of Rev. T. E. R. Phillips' recent paper on this subject (Mon. Notices R.A.S., 85, p. 179, 1924), in which micrometric measurements are given showing that the melting of the snow proceeded slowly during July, but that the cap diminished rapidly in size during August and September, and became very small in November.

This rapid rise in temperature of the south polar region from -60° (the temperature of the isothermal layer of the polar canopy; 0°C . if interpreted from the visual observations of the receding cap of melting ice) in July to 10°C . or even higher at the Martian summer solstice (on October 5) is perhaps one of the most important results of this investigation. From a consideration of the prolonged insolation on the south polar region, such a temperature rise is to be expected.

On the west limb the observed temperature was -2° to -8°C . at the beginning of August, when there was a small dark phase. When there was no dark phase on the west limb the temperatures ranged from 0° to 6°C .

Perhaps the most interesting series of measurements relate to the east limb or sunrise side of the planet. During the first part of August, the east limb was irradiated for an hour or more before turning into view. Under these conditions the observed temperatures of the eastern limb range from -10° to -20°C . At opposition, August 22, when there was no dark phase, the temperature was down to -45°C . At the conclusion of the series at the 53.3 foot focus, on September 12, when the dark phase was barely perceptible on the east limb (illuminated surface 0.976), the temperature was -60°C . How much lower the temperature falls, and whether this very low temperature is owing to setting the receiver on the atmospheric envelope, remains to be determined.

From the low temperatures recorded at the poles, and the small atmospheric envelope, it appears that the temperature of the night side of Mars may fall below -70°C .

This study of the seasonal changes in temperature, especially of the southern hemisphere of Mars, was continued late into November by Mr. Lampland, using the same radiometric equipment and galvanometer employed by us during the preceding months. He reports that the water-cell transmissions of the radiation from the north polar region continued unchanged, at

70 to 80 per cent., indicating a temperature of about $-70^{\circ}\text{C}.$, as was to be expected with winter on this hemisphere.

On the other hand, the water-cell transmissions of the radiation from the south polar region decreased from the high value observed in the early part of September to 30 per cent., or even lower, in November and December, indicating a temperature of 10° to $15^{\circ}\text{C}.$, or even higher. Granting that some ice still remained at the pole, there would be a temperature gradient for which a correction should be made. On this basis, the water-cell transmissions would be still lower and the temperature of the south polar region would be higher than indicated by these measurements.

The observed high surface temperatures on Mars

may be accounted for on the assumption that these dark areas contain vegetation having the properties of the tuft-forming grasses of our high prairies, and the tussock mosses and lichens of our dry tundras, which have a high absorptivity for solar radiation and a low thermal conductivity. The assumption of the presence of such a type of vegetation is in harmony with the visual observations, which show changes in the colouring of the dark areas with changes in the seasons, and it is in agreement with the lower intensity of insolation on Mars. The radiometric observations indicate that during the summer season on Mars, temperature conditions at noonday are not unlike the bright cool days on this earth, with temperatures ranging from 5° to 15°C or 40° to $60^{\circ}\text{F}.$

Sir William Thiselton-Dyer and the "Flora Capensis."

THE publication in the *Kew Bulletin* (No 7, 1925, pp 289-293) of an account, by Sir W. T. Thiselton-Dyer, of the commencement, progress, and completion of the "Flora Capensis," affords a fitting opportunity of recalling Sir William Thiselton-Dyer's work at the Royal Botanic Gardens, Kew, and more especially the work he has done for the British Empire in advancing the knowledge of its botanical riches in the domain both of economic and systematic botany. With regard to the systematic study of the Colonial floras, the two works which are especially associated with his many years of office at Kew are the "Flora Capensis" and the "Flora of Tropical Africa." Proposals for both these works were made by Sir William Hooker, so long ago as 1863, when *inter alia* he put forward a proposal for a flora of the "South African Colonies" in ten volumes and a flora of the "West African Colonies" in two volumes. Out of the former proposal has come the now completed "Flora Capensis" and from the latter the "Flora of Tropical Africa," which, when finished, will occupy eleven or twelve volumes.

The "Flora Capensis," as Sir William Thiselton-Dyer states, had, however, actually been commenced at the suggestion of Sir William Hooker. It was undertaken by Dr. Harvey, "sometime Treasurer of Cape Colony," the professor of botany in the University of Dublin. He "undertook to print and publish the Flora at his own risk and cost, trusting chiefly to colonial subscriptions for a repayment of the outlay." Dr. Sonder, of Hamburg, "gladly accepted Dr. Harvey's offer to share the authorship." Volume 1, dedicated to Sir George Grey, K. C. B., "Governor and Commander-in-Chief of the Colony of the Cape of Good Hope," bears the publication date 1859-60. Volume 2 was published in 1862, and Volume 3 in 1865. The following year Prof Harvey died, and Dr. Sonder, who took no further part in the work, died in 1881.

Sir Henry Barkly, Governor of the Cape of Good Hope from 1870-77, himself an ardent naturalist and fellow of the Royal Society, urged upon Sir Joseph Hooker, who had succeeded his father as director of Kew, the completion of the work of Harvey and Sonder, and Sir Joseph Hooker suggested to Mr. Dyer, as he then was, that he should undertake the completion of the work of the Cape Flora. As, however, he was at that time assisting Sir Joseph in sub-editing the

"Flora of British India," he was unable to entertain the proposal, and later, being appointed to the post of assistant director of Kew in 1875, he was again precluded from taking up any particular part of the Flora himself. Sir William, however, was able to enlist the aid of numerous contributors in carrying on the work; but the general task of supervising and editing a work which was part of a project initiated by Kew, appeared to him to fall naturally within the scope of his official duty, and so after a long interval the "Flora Capensis" was again started.

Sir William points out as a striking fact, that in the volumes published by Harvey a very large number of the species are only represented by a single collection. It was highly desirable to have more copious material to work upon, if only to supply more ample data for geographical distribution, and thanks to Sir William Thiselton-Dyer a numerous body of contributors was marshalled, and they rendered valuable service in sending home material for the adequate working out of the Flora. Among these Peter MacOwan and Dr Harry Bolus deserve particular mention.

Sir William, in his article, refers to the fact that upwards of ten thousand specimens have been named and catalogued for South African botanists and collectors in connexion with the work of the Flora, and that during twenty years, from 1877, the time of one member of the Kew staff, Mr. N. E. Brown, was almost exclusively occupied with the determination of these fresh accessions of South African plants. Sir William bears eloquent testimony to Mr. Brown's work, pointing out that from his complete mastery of the features of the flora and of South African topography "he has been the invaluable mainstay of my own share in the undertaking."

It was in 1877 that Sir William was able to start the work on the Flora on an effective basis, and he was fortunate in being able to secure the co-operation of South African contributors, including Dr. Harry Bolus, who undertook the Ericaceæ; Dr. E. P. Phillips, who worked out the Proteaceæ; and Miss E. L. Stephens, who worked out the Penæaceæ. The Orchids, which should have been worked out by Dr. Harry Bolus, could not be carried out by him and were undertaken by the late Mr. R. A. Rolfe of the Kew Herbarium staff. Other contributors of whom Sir William makes special mention were Mr. J. G. Baker, who elaborated

the "Cape Bulbs," and Mr C. H. Wright, assistant in the Herbarium, Royal Botanic Gardens, Kew, who sub-edited the whole of the contributors' manuscript.

It is interesting to note that Sir William Hooker estimated both the number of volumes and the financial support that would be needed to carry out the work with remarkable accuracy. He fixed the number of volumes at ten, which is the number now published, and he also estimated that ten thousand would be the number of species to be dealt with. The actual number, however, is 11,705, and of these 2016 are described for the first time.

The "Flora of Tropical Africa," like the "Flora Capensis," though it owes so much to the energy and sagacity of Sir William Thiselton-Dyer, was commenced before he was able to assume any control over its preparation. Originally it was intended to be the joint work of Sir William Hooker and Prof. Daniel Oliver, Keeper of the Kew Herbarium; but the work was handed over to Prof. Oliver, and the first three volumes appeared in 1886, 1871, and 1877 respectively. Then, as with the "Flora Capensis," came a long break, and it was not until Sir William Thiselton-Dyer was able to take the matter in hand that the preparation of this flora could be resumed. As an outcome of his activities a new volume of the Flora appeared in 1898 devoted to the petaloid monocotyledons, Volume 7 of the entire work, this being the first volume to be produced under Sir William's editorship. This was followed in due course by Volume 4, published in two sections, Volume 5, Volume 8 and Volume 6, Section 1, the latter, which was published in 1913, being the last to appear under his editorship. The Flora has been continued under the editorship of Sir David Prain, and only some two parts, dealing with the grasses, now remain to be published.

The work entailed in arranging for the collection and naming of the material for these two great works would, it might well be thought, be sufficient to have occupied the full attention of the director of Kew, upon whose time there are so many calls with regard to botanical problems both at home and abroad; nevertheless, Sir William found time to initiate yet another work, *The Kew Bulletin of Miscellaneous Information*, for the purpose, more especially, of disseminating knowledge about the economic botanical

products of the Empire. The *Bulletin* was started in 1887 and is still in a flourishing condition, despite one or two times of difficulty—one of which was during the War, when an attempt was made to suppress it on the mistaken idea of economy.

Sir William's preface, which we quote, fully explains the scope and purpose of the work:

"It is proposed to issue from time to time, as an occasional publication, notes too detailed for the Annual Report on economic products and plants, to which the attention of the Staff of the Royal Gardens has been drawn in the course of ordinary correspondence, or which have been made the subject of particular study at Kew. It is hoped that while these notes will serve the purpose of an expeditious mode of communication to the numerous correspondents of Kew in distant parts of the Empire, they may also be of service to members of the general public interested in planting or agricultural business in India and the Colonies.

"W. T. THISELTON-DYER,
"Director.

"1st January 1887."

The present condition of the Kew Museums is also largely due to Sir William Thiselton-Dyer. Originally started by Sir William Hooker, the collections grew apace and fortunately they came under Dyer's purging hand, with the result that much encumbering dross was removed and the economic products were displayed to the best possible advantage. At the same time the Museum guides were produced and put on sale, in order that the public might be provided with accurate information on the wealth of the vegetable kingdom and the economic products derived therefrom.

These, with the two African floras and the *Kew Bulletin*, are a record of service which is of the highest importance, not only in the development of our knowledge of the botanical resources of the Empire but also because of the impetus this gives to scientific research in botany.

Such services as these, and many other activities displayed by Sir William Thiselton-Dyer in various botanical enterprises, have rarely been surpassed in value and importance by the labours of any other public servants to whom the British Empire owes so much.

Obituary.

PROF. FELIX KLEIN, FOR. MEM. R.S.

FELIX KLEIN, who was born at Düsseldorf on April 25, 1849, died on June 22, 1925. He had been professor at Göttingen since Easter 1886, having previously been at Erlangen (1872-1875), Munich (1875-1880), and Leipzig (1880-1886). With a trenchant expository style, revealing a forceful genial character, he wrote on almost every branch of mathematics; he was editor of the *Mathem. Annal.* from the time of the death of Clebsch (1872), originator of the "Enzyklopadie" for mathematics and mathematical physics (from 1895), and, in his own country, worked incessantly for a living co-operation of physics, engineering, and mathematics, and (since 1908) to bring the teaching in the schools into touch with current scientific problems. He was also a constant traveller and lecturer, was

twice in America and many times in England, since 1873. His exceptional personality appeared at once after his student days at Bonn; he took his doctor's degree at the age of nineteen; issued the second part of Plücker's book on line-geometry at the age of twenty; by the end of 1871, when he was twenty-two, had published eighteen original papers (some of these with Lie); by the end of 1875 he had published forty. Many of these are still mines of suggestiveness; his Erlanger Programm (1872) has been translated into English, French, Italian, Polish, Russian, and Hungarian.

Klein's mathematical papers were published, under his own supervision, in three volumes, in 1921-1923, containing more than two thousand beautifully printed pages; in these is inserted a running personal commentary; in effect, a detailed account of his scientific

thoughts and aims from the age of eighteen, with many references to colleagues and pupils. These volumes, intensely interesting from so many points of view, are the sufficient and authentic basis for a review of his life.

It appears, what will be new to many, that Klein's life was lived under a resolve, never relinquished, made when serving Plucker as assistant for his lecture on experimental physics, to devote himself to physics. He desired only, first, as a preparation for this, to make himself acquainted with all branches of mathematics, in order to trace the connexions of their leading ideas, and to be in a position to raise physics to a higher plane. The notes enable us to trace how this resolve was modified by circumstances, and only realised in the work of others whom he inspired: two leading causes are brought out—his pre-eminently sympathetic temperament, and a serious breakdown of health at the age of thirty-three. It seems clear that he worked mainly by discussion with friends and pupils, and by lecturing. His vivid account of the time spent with Lie in Paris in the early part of 1870; his evident interest in meeting Sylvester, Cayley, Clifford, and Ball at the British Association at Bradford, in 1873, and the reference to the happiest time of his productive activity (1876–1880), when he, from Munich, and Gordan, from Erlangen, each travelled a long way to enjoy on Sundays a *Mathesis quercupolitana* at the half-way Eichstadt, are examples of what appears throughout.

Now such discussions were conditioned by the interests of his colleagues, as his early work had been influenced by his teachers (Plucker, Clebsch, Weierstrass, Kummer); and thus Klein was led into giving his publications a form quite other than physical. We see, however, how he fought to maintain his early resolve, particularly in the manner of approach to Riemann's theory of functions, and, later, in his volume (with Sommerfeld) on the motion of the top. This begins in a mathematical way; but, in the course of the thirteen years occupied in its publication, reaches a very technical plane. But besides this concession to his surroundings, it appears that, first at Munich, and then more seriously at Leipzig (in 1882), he was warned that he could not continue to work with the same intensity, and must needs live on a different level. Thus he began to limit himself to the supervision of the long series of books and lectures, on almost every subject of mathematics and mathematical physics, of which the detailed work was carried out by others.

Meanwhile Klein's unceasing anxiety for the organic working union of physics and mathematics expressed itself in administrative ways. He secured, one can imagine with what trouble, a co-operation of German Academies, to bear the responsibility for the "Enzyklopadie", he travelled hither and thither to secure competent contributors, especially to England (there being, as he explains, no sufficient sympathy in Germany between mathematicians and physicists), himself undertook the part dealing with mechanics, in connexion with which he obtained the translation into German of Routh's "Dynamics," Lamb's "Hydrodynamics," and Love's "Elasticity." In his own Göttingen, later on, were founded a Physical Institute, with the help of German manufacturers, and a society for the encouragement of mathematical physics; to him it appeared

"Mechanik, überhaupt angewandte Mathematik, kann nur durch *intensive Beschäftigung mit den Dingen selbst gelernt werden*; die Literatur gibt nur eine Beihilfe." He took every opportunity, by visits to conferences and lectures, to keep in touch with engineers and physicists, he organised vacation courses for teachers to give their teaching the proper modern orientation; and finally, from 1908, he gave his attention to the schools, and lamented the ruin the War had wrought in the extensive preparations made for an international campaign.

Little need be said in this place of the brilliance of the mathematical papers, especially of Klein's earlier years. If the reader agrees with Poincaré, in a letter quoted here, "Je ne crois pas qu'une démonstration puisse être résumée; on ne peut en retrancher sans lui enlever sa rigueur et une démonstration sans rigueur n'est pas une démonstration," he will find here, also, Klein's reasoned reply. Nor need we think that his international aims were not genuine because of his evident patriotism, and his desire to see Göttingen "über Alles." These are desires which he would have commended in others. For we are bound to feel that his life was devoted to a very real and practical problem of our time, and that he worked at it loyally and unremittingly—namely, how to bring under as few points of view as can be grasped by one man the astonishing output of physical and mathematical thought in the last hundred years. The difficulty is not that the ideas involved are so wide apart, on the contrary, they are very cognate—Bohr uses the ideas of the theory of Abelian functions, and would use the approximation theory elaborated by Lagrange, combined with Planck's physical results, to construct an explanation of spectrum lines; Einstein uses an absolute differential calculus, tracing its origin to Lie's work for continuous groups as well as to Riemann's thoughts on geometry, with a realistic outlook such as was discussed by Mach, to found a new calculus for the motion of material bodies. It is probably the case that the grooves in which the mind of the physicist can move, to elaborate his theories, have generally been worn by the imagination and systematising efforts of the mathematician, who, in rare cases, may be the same person; and it is certain that only by the development of all aspects of thought can progress be continued. But how shall one man secure an adequate understanding of all that may concern him in the work of so many others? Must we say that the answer is that only if the civilised world can continue in patience and amity to co-operate to this end, can the end be reached?

At least we owe honour to the commanding personality and penetrating intellect of Felix Klein, for his life's devotion to the solution of the problem.

COUNT GOBLET D'ALVIELLA.

THE death of Count Goblet d'Alviella on September 8 as the result of a motor-car accident is announced from Brussels. Count Goblet d'Alviella was born in 1846, and for some time was professor of the history of religion at the University of Brussels. He had a distinguished career in public life successively as a member of the Chamber of Deputies, member of the Senate, of which he became vice-president in 1912, and Minister of State and member of the cabinet during the War.

He held the degree of doctor of philosophy, and the Universities of Edinburgh and Glasgow had conferred upon him honorary degrees. In 1891 he delivered the Hibbert Lecture, his discourse being published afterwards under the title, "A Lecture on the Origin and Growth of the Conception of God as illustrated by Anthropology and History." He was the author of a number of books, including "Sahara and Lapland. Travels in the African Desert and the Polar World," which was published in an English translation in 1874, and "The Contemporary Evolution of Religious Thought in England, America, and India," published in England in translation in 1885.

Goblet d'Alviella's most important work, however, was "La Migration des symboles," published in Paris in 1892, and in an English version with a preface by Sir George Birdwood in 1894. This book embodied material originally appearing in the *Bulletin de l'Académie Royale de Belgique* and elsewhere, but in much extended form. The study of forms of symbolism had at that time fallen somewhat into disrepute owing to the unscientific and highly speculative methods of earlier writers such as Depuis and Creuzer, but Goblet d'Alviella placed it on a secure footing by the application of inductive methods and comparative study. As Sir George Birdwood said in his foreword, he "raised the inquiry to its proper position as a department of archaeological research, producing a work destined to exert an abiding influence on the whole future of the study of symbolism"—a prediction which time has not belied. This book still remains the best study of the principal symbols employed in early decorative art, such as the swastika, the triskele, the tree of knowledge, and the winged disc. It is interesting to note that while Goblet d'Alviella derived each of such symbols in the main from a single origin in some one centre, he was prepared to admit that in certain areas and in favouring circumstances they probably had arisen independently.

WE regret to announce the following deaths.

Prof. C Chandler, formerly professor of chemistry at Columbia University, New York, a former president of the American Chemical Society, and an original and an honorary member of the Society of Chemical Industry, aged eighty-eight years.

Prof. Albert T. Clay, professor of Assyriology and Babylonian literature in the Graduate School of Yale University, and president of the American Society for Oriental Research, on September 14.

Sir Francis Darwin, formerly reader in botany in the University of Cambridge, on September 19, at seventy-seven years of age.

Dr. William C. Farabee, curator of the American section of the University of Pennsylvania Museum, distinguished for his archaeological and ethnological work in South America, on June 24, aged sixty years.

Prof. W. S. Hendrixson, professor of chemistry since 1890 at Grinnell College, Iowa, known for his contributions to the study of electrometric methods in chemistry, on July 1, aged sixty-six years.

Senator E. F. Ladd, formerly professor of chemistry at North Dakota College and president of the Agricultural Experiment Station, on June 22, aged sixty-five years.

Dr. Georg von Mayr, professor of political economy and statistics in the University of Munich and an honorary member of the Royal Statistical Society, aged eighty-four years.

M. Auguste Pavie, an honorary corresponding member of the Royal Geographical Society, who carried out important explorations in Indo-China, Siam and Upper Annam, adding considerably to our knowledge of French possessions in Asia, aged seventy-eight years.

Prof. F. Ranwez, professor of pharmaceutical chemistry in the University of Louvain and president of the International Congress of Pharmacy held at Brussels in 1897, aged fifty-nine years.

Dr. Georg A. Schweinfurth, distinguished by his geographical, botanical, and ethnographical work in Africa, on September 19, at eighty-eight years of age.

Dr. A. Tuckerman, known especially for his bibliographic work in the United States on the literature of the spectroscope and of thermodynamics, on May 25, aged seventy-seven years.

Prof. Charles Vélain, the first occupant of the chair of physical geography in the Faculty of Sciences of the University of Paris and founder of the "Revue annuelle de Géographie," on June 6, aged eighty years.

Prof. J. B. Woodworth, of the Department of Geology and Geography at Harvard University since 1890, a pioneer in the scientific study of earthquakes, who was also known for his work in the glacial geology of Brazil and other areas, on August 4, aged sixty years.

Current Topics and Events.

At the recent meeting at Southampton of the British Association, it was a subject of general remark that modern scientific thought shows a striking drift away from the facile generalisations of the Victorian age. The progress of research in the sciences bearing on agriculture illustrate this change to a very marked degree, and the report of the Rothamsted Experimental Station for the years 1923-1924, which has just been issued, bears witness to the number and variety of the investigations in progress at the premier institution for agricultural research in Great Britain. The list of scientific papers published from the Station during the period reached the remarkable total of fifty-eight. The Physics Department alone was responsible for thirteen papers, of which three appeared in the Proceedings

of the Royal Society. Under the various sections of this report dealing with the many physical and biological factors which enter into plant growth, we are constantly met with references to the interplay of contending forces. In the soil, in place of absolute values assigned to specific plant nutrients (*teste* Page), colloidal calcium- and other complexes now figure as the battle-ground of warring ions, and in the biological field, as the work of Cutler and Thornton has shown, much depends on the ebb and flow in the bacteria-protoczoa conflict. Superimposed on all these come the vagaries of the weather, an extraordinarily difficult factor to measure. The work of evaluating all these factors falls to the Statistical Department, the activities of which (perilously esoteric!) are ably directed by Mr. Fisher.

THE outlook of Rothamsted is, in the main (and rightly) academic, but if there is any department the concern of which more intimately touches upon existing economic conditions, it is that dealing with the physics of the soil, in charge of the Assistant-Director, Dr Keen. Costs of "cultivations"—man and horse labour—may approach three-fourths of the total cost of home-grown crops, and, at the present rates of wages, the homeland is almost hopelessly handicapped—a topic, by the way, prominently brought to notice at the Southampton meeting by Sir Daniel Hall and Sir Henry Rew. It may be hoped that the new Research Institute in Engineering recently founded at Oxford will find it possible to enter into intimate co-operation with the fundamental work on cultivations now going on at Rothamsted. We notice a reference in the report to a matter of considerable public interest, and that is, the problem of exploiting, on a commercial scale, discoveries made in laboratories supported by large grants from the State. The Rothamsted authorities are happy in finding, in Lord Elveden, a patron who is willing to undertake the commercial development of the discovery made by Hutchinson some years ago of a method of making "artificial" farm-yard manure. The report also contains the details of the various field experiments which are in progress at Rothamsted, as well as full particulars of the interesting investigations conducted by Dr Voelcker at the farm at Woburn, the maintenance of which the Royal Agricultural Society somewhat precipitately jettisoned some years ago.

At the second Pan-Pacific Science Congress held in Australia in the summer of 1923, the invitation of the Japanese delegation to hold the third congress in Japan in 1926, under the auspices of the Japanese National Research, was accepted, and a preliminary announcement has recently been issued. The main objects of the Congress, like those of 1920 and 1923, will be the promotion both of co-operation in the study of scientific problems affecting the Pacific region and of the sense of brotherhood among the scientific workers of the countries concerned as a means of strengthening the bonds of peace among the Pacific nations. To these ends, the programme will consist largely of symposia upon selected subjects. Three discussions suggested provisionally for general sessions of the whole Congress deal with the physical and biological oceanography of the Pacific, radio-transmission in the Pacific region, and the geotectonics of the Pacific area, respectively. The provisional programme for the Division of Physical Sciences includes discussions, with special reference to the Pacific region, on solar activity, terrestrial magnetism, meteorology, the strand-line during Pleistocene and post-Pleistocene time, the correlation of Mesozoic formations, metallogenic epochs, volcanoes, and earthquake-proof constructions. The Division of Biological Sciences will probably discuss the floras and faunas of the various countries and islands of the Pacific and their relationships, plant successions and quarantines, the protection of aquatic animals, the genetics of live-stock and crops, particularly rice, the antiquity of

man, and the diseases of native races. Other suggested discussions deal with astronomical observations, earthquake observations, geodesy, oil-bearing formations, thermal springs, storage of cereals, green manuring, diseases of animals, anthropometry, tropical diseases and food, drugs, clothing, and housing in the Pacific region. It is stated that the committee authorised at the Congress in 1923 to effect a permanent organisation of scientific institutions of the countries of the Pacific has been set up. It contains representatives of the countries of the region and of the European powers interested in the Pacific.

THE International Commission of Eugenics is a body originally nominated by the International Eugenic Congress with power to co-opt additional members. The International Congress of Eugenics meets every five years, and the Commission was intended to afford eugenists opportunities for the exchange of views and mutual consultation at more frequent intervals. The fourth meeting of the Commission was held in London in July, the third meeting having taken place last year at Milan. The London meeting was attended by representatives from the United States, France, Holland, Belgium, Italy, Denmark, and Norway. Two important resolutions were agreed to, the first moved by Dr Davenport, the American representative, to the effect that, as every nation has a right to determine who shall be included in its body politic, so it is expedient that every immigrant-receiving country should inquire into the family and personal history of each would-be immigrant, and the second, also moved by Dr Davenport, that the standard pedigree chart devised by Miss Van Herwerden should be printed and published by the Commission as the best and most practicable form of recording such histories. Dr Collin, one of the Norwegian representatives, agreed to summarise the most recent theories as to the causes of the rise and fall of civilisations, and report on the subject to the next meeting of the Commission. Dr Mjoen, the other Norwegian representative, delivered an interesting lecture on the inheritance of musical ability. He showed clearly that it was impossible to explain this inheritance as the results of the passing on and segregation of a Mendelian factor. He adopted the device of postulating the existence of numerous factors inherited separately, these factors were, however, arbitrarily chosen and ill-defined.

In a report circulated by Science Service of Washington, D.C., which appears in *Science* for August 2, it is stated that a joint expedition of the Smithsonian Institution and Amherst College has discovered a crushed human skull associated with stone arrow-heads and the remains of mammoth and mastodon near the towns of Melbourne and Vero, Florida. Above the elephant stratum pottery was found among an accumulation of recent shells, and in the sands below, teeth of horse, camel, and sabre-toothed tiger, indicating a characteristic Pleistocene fauna. Dr. J. W. Gidley, leader of the expedition, is confident that the human remains were not buried in the

mammoth strata. The inference drawn is that the mammoth and mastodon survived in this area of Florida for some 10,000 years after those of which the remains have been recently discovered in Indiana and are assigned to the late Pleistocene. The result of further investigation of the evidence will be awaited with interest, and should it confirm the conclusion here stated, the late survival of the mastodon may serve as a possible explanation of the association of human remains with bones of the mastodon at Natchez, which those who deny high antiquity to man in America have hitherto been constrained to explain as due to burial or fortuitous causes and as affording no evidence for contemporaneity.

As agreed at the conclusion of the World Power Conference held at the British Empire Exhibition, Wembley, last year, the International Executive Committee met in July last for the purpose of discussing the future activities of the movement. An invitation to hold the second World Power Conference at Basel in 1926, on the occasion of the Internal Exhibition for Inland Navigation and Utilisation of Hydraulic Power, was refused on the ground that a longer period than one or two years was desirable between plenary sessions of the Conference. Meanwhile, however, it was decided to hold sectional meetings in various areas, under the auspices of the International Committee, to discuss programmes on specific subjects within the general conference programme. An invitation was accordingly sent to the Swiss National Committee to hold a sectional meeting at Basel in 1926 for the discussion of the development of hydro-electric power combined with inland navigation, the interchange of electric power between countries, the economic relation between hydro- and thermal power, railway electrification and electricity in agriculture, stress being laid particularly on financial and economic aspects. The International Executive Committee further recommended, as a means of securing the continuity of the Conference movement, that a *Journal of the World Power Conference* should be published at regular intervals. It was decided, subject to reconsideration at a later meeting, that the second World Power Conference should be held at Rome in 1930.

In the *Lancet* of September 12 there is an important paper on the experimental treatment of implanted malignant tumours of the rat, by Dr. Thomas Lumsden, of the Lister Institute. A short time ago, Dr. Lumsden published the results of the action of an anti-serum which had been prepared by injecting rats or rabbits with emulsions of ground-up cancerous tumours of mice. When such a serum was brought into contact with cultures of cancer cells, the latter were injured or destroyed. Normal serum had no such effect, and the cancer serum had no effect on cultures of cells other than cancerous. Thus a fragment of heart culture could flourish and beat in anti-cancerous serum. Dr. Lumsden, in his new paper, has extended these results to the possible therapeutic action of such anti-sera. When rats were inoculated on the foot with a fragment of Jensen rat sarcoma—a highly malignant tumour—the resulting new growth could

be made to disappear when the anti-serum was injected locally and prevented from diffusing itself through the body too quickly. Remarkable to say, the animal, after the cure of its tumour by serum, was found to be immune and could not be reinfected. When rats were inoculated on two of their feet, the resulting tumours both disappeared when the serum was injected locally into only one of the tumours. Further developments of this work will be awaited with interest.

THE probable rainfall in India during August and September, based on the weather in India in June and July, associated with the weather conditions in other parts of the world which are most likely to influence the coming rains in India, was issued on August 7 to the Government of India by the Director-General of Observatories. In both June and July the monsoon was normal in activity, the rainfall for the two months over the plains as a whole was about 5 per cent in excess of the normal. There was an excess of more than 50 per cent in Orissa, the United Provinces west, and the Punjab east and north; of 20 to 50 per cent in the United Provinces east, Baluchistan, Rajputana east, Central India east and the Central Provinces east; and a defect of 20 to 50 per cent in Kashmir, Sind, Berar, Hyderabad north and Mysore. In the remaining subdivisions the total rainfall of the period was within 20 per cent. of the normal. It is summarised that there is no strong reason to expect any large excess or defect in the total rainfall of August and September, either in north-west India or in the Peninsula. The Bombay correspondent of the *Times* reports, however, under date September 19, that the monsoon, which until a fortnight ago was favourable everywhere, shows signs of failing, and that rain is badly needed in many districts in the south of India.

AN adequate supply of pure distilled water is an indispensable requisite in all chemical and in most physical laboratories. If the consumption be very small and the degree of purity required be only "reasonable," the commodity can usually be purchased with impunity from the local druggist, but in all other cases it must be prepared in the laboratory. Common defects of the ordinary still are painfully slow rate of production, and "accidents" with the gas or water-supply. The patent automatic tin-lined stills supplied by Messrs. Brown and Son (Alembic Works), Ltd., of 9 Wedmore Street, London, N.19, as has been found from many years' experience, are free from these faults. The rate of distillation secured with this still is many times greater than that obtainable with any of the old-fashioned types, and the mechanical device, ensuring that the water-supply is turned on simultaneously with the gas-supply, makes the apparatus as fool-proof as possible; it does not, however, prevent minor mishaps due to fluctuating pressure in the gas and water mains. Such fluctuations are a source of great annoyance in many chemical and physical operations, and simple, cheap devices for counteracting them are badly needed. The new catalogue issued by Messrs

Brown and Son contains illustrations and particulars of stills heated by gas, steam, or oil, together with information concerning their output per hour.

IN Bulletins 746 and 747, the United States Geological Survey has published a Bibliography and Index to the "Geologic Literature on North America, 1785-1918," compiled by John M. Nickles. These two volumes will be extraordinarily useful to geologists all over the world. The flood of geological literature is so great that it is always difficult to keep pace with it, and an important work of reference such as this is what the late Prof. Cole would have called a very real aid to practical geology. It should be noticed that the publications indexed refer to the whole of North America from the West Indies to the Arctic and to the Hawaiian Islands. In Part I. the names of authors are arranged in alphabetical order, papers being listed in chronological order in each case. About 45,000 titles are indexed in this way. Part II. is a subject index and contains about 70,000 headings.

THE officers of the Röntgen Society for the session 1925-26 are as follows.—*President*, Dr. F. W. Aston; *Vice-Presidents*, Dr. Robert Knox, Mr N. S. Finzi, Prof A. W. Porter; *Hon. Treasurer*, Mr. Geoffrey Pearce; *Hon. Editor*, Dr G. W. C. Kaye, *Hon. Secretaries*, Dr. E. A. Owen, Mr Russell J. Reynolds

DR WILLIAM C. REYNOLDS, referring to his letter in NATURE of September 12, p. 394, states that data regarding the troposphere and stratosphere provided in Dr. G. C. Simpson's presidential address to Section A (Mathematics and Physics) suggest that the optical, electrical, and thermal zones probably coincide—a simple and important geophysical condition. An aeroplane observer at sunrise and sunset should, therefore, have three separate methods of determining the limits of the lower zone. Such data regarding the thermal zones as Dr. Reynolds had when writing his earlier letter appeared to place the stratosphere higher up.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned. An assistant lecturer and demonstrator in engineering and an assistant lecturer and demonstrator in mining and mine-surveying at the University College of South Wales and Monmouthshire, Cardiff—The Registrar (October 3) A senior lecturer in pure mathematics in the University of Cape Town—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, W C 2 (October 20). Junior technical assistants in the wireless experimental department of the Royal Aircraft Establishment—The Superintendent, R.A.E., South Farnborough, Hants (quoting A 79).

Our Astronomical Column.

BROOKS' PERIODIC COMET—A telegram from the International Astronomical Union Bureau, Copenhagen, announces the detection of this comet by Prof Tcherny at Kief Observatory; its position on Sept. 19 at 19^h 9.5^m Universal Time being R.A. 23^h 17^m 36.9^s, S. Decl. 5° 12' 11". The magnitude was 9.5, considerably brighter than the predicted value, which was about 12; there is therefore a possibility that the comet is not identical with that of Brooks. The R.A. is 18^m 49^s in excess of Prof. Dubiago's prediction the Decl. 15 3' south of it. The predicted elements were:

$$\begin{aligned} T &= 1925 \text{ Nov } 8, 5838 \text{ U.T.} \\ \alpha &= 195^\circ 48' 59.4'' \\ \Omega &= 177^\circ 25' 36.5'' \\ i &= 5^\circ 42' 44.6'' \\ \phi &= 29^\circ 0' 41.0'' \\ n &= 510.9845'' \end{aligned} \quad \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} 1925 \text{ O.}$$

The correction to T from the R.A. is -5 354 days. that from the Decl. +0 942 days. These are considerably discordant, and strengthen the suspicion of non-identity. If it is Brooks', the appropriate weights are 3 to R.A., 1 to Decl.; weighted mean -3 78 days.

The perturbations at the last aphelion passage were very large, the distance from Jupiter being less than 8 million miles. Curiously, Wolf's Comet made a similar approach at about the same time.

The following ephemeris for O^b is found from that of Dubiago by applying +18^m 49^s and -15 3'.

	R.A.	S. Decl.
Sept. 26	23 ^h 15 ^m 47 ^s	6° 1'
" 30	23 14 58	6 31
Oct. 4	23 14 34	6 57
" 8	23 14 33	7 20
" 12	23 15 0	7 40
" 16	23 15 56	7 56

On Sept. 26 the comet is due south about 23^h. Its distance from the earth is 0.9 unit.

MARS—Prof W. H. Pickering observed Mars last year from Mandeville, Jamaica, and gives in *Popular Astronomy* for August-September an interesting summary of his own and other observations. He reproduces some early photographs of Mars taken on ordinary plates in 1888 and 1890. Some of these show the prominent markings obliterated by a whitish veil, like Mr Wright's recent photographs on ordinary plates, this corresponds (as both observers noted) to the fact that terrestrial photographs on ordinary plates fail to show distant objects plainly visible to the eye, while red-sensitive plates show them. Others of the old photographs show the dark markings plainly, indicating that the clearness of the Martian atmosphere is subject to large variations. Prof. Pickering agrees with Mr. Wright in concluding that the atmosphere is denser and more extensive than was recently thought probable. He argues in the same direction from the recent thermopile measurements, which indicated a temperature well above the freezing point. As the desert regions showed a lower temperature than the maria, he conjectures that they are more elevated. Assuming a temperature gradient similar to that on earth, he gives the mean elevation as 8000 feet.

There are detailed descriptions of some of the large clouds that appeared in the equatorial regions at the last apparition. One of these was 1200 miles by 500 miles, its rate of motion being 24 miles per hour.

In common with several other observers, Prof. Pickering looks on the presence of vegetation on Mars as practically assured, and presumes that this implies the presence of at least some forms of animal life. There has been a pendulum-like swing in views on Mars, in the middle of the last century it was generally looked on as a miniature of the earth. Towards the end of the century the view of its non-habitability was widely held, now we notice a tendency to revert to the earlier view.

Research Items.

A CHIBCHA TEMPLE IN COLOMBIA—In 1924 an official Commission identified and investigated the site of the Chibcha Temple of Suamox, which was burnt in 1537 by the troops of Quesada, who had been attracted thither by reports of its riches. The Commission consisted of Gerardo Arrubla and General Carlos Cuerva Márques, the former of whom describes the results of these investigations in the English edition of *Inter-America* for August. By a careful examination of the chronicles and traditions and of trustworthy witnesses, and by exploration on the ground, the Commissioners were able to fix the site of this Temple of the Sun with certainty in the city of Sagamoso itself. Excavation confirmed the traditional account that it had been built of wood and had been destroyed by fire. Tradition also has it that the wood used had been carried from a great distance on the backs of the Indians. It was found that the wood of the temple columns does not grow in the valley or nearer than the plains. Each pillar was said to have been erected on the body of a sacrificed slave, and human remains with small objects of gold, stone, clay, and shell were actually discovered at the base. The temple was circular in form and had a diameter of 36 metres, a remarkable size considering the rudimentary architecture of the Chibcha.

THE ORIGIN AND DISTRIBUTION OF TREPPANNING—Dr Wolfel of Vienna has made an exhaustive study of the practice of trepanning among primitive peoples, of which Part I appears in Hefte 1-2, Bd xx, of *Anthropos*. The operation was practised in prehistoric Europe and in North Africa, it persisted in Albania and Serbia and among the Berbers. It occurs in Melanesia and New Guinea, and a number of skulls have been found in America which show that it was employed by the inhabitants of the Mississippi Basin, in Mexico, and in the Andean region. In the present section of his work, Dr Wolfel deals with Melanesia and New Guinea and America, and, after a comparative study, concludes that in these two areas it is an element in a common culture complex. In Melanesia and New Guinea its use is mainly surgical, especially for healing wounds caused by stone clubs or sling stones by removing fractured bone. It is also practised for epilepsy and headache, as a matter of fashion, and to secure longevity. It has also a magical implication. Essentially, however, it is to be connected with the use of the stone club and sling in war. Turning to America, the skulls which have been found, occurring even so far north as Lake Huron, show that trepanning was adopted as a method of dealing with a crushing blow, such as might be caused by a stone club or sling. Here also there is evidence of disease, and MacCurdy directs attention to traces of cauterisation. Although the existence of the sling in pre-Columbian America has been denied, there is sufficient evidence to call for the revision of this conclusion, e.g. in the Winland slingers of the Saga of Eric the Red, the Algonkin devil-head slings, among the Beothuk of Newfoundland, and so on. The existence and distribution of stone-headed clubs is also well attested. It is therefore to be concluded that trepanning is an element in a culture complex which was associated with the stone-headed club and coheres with the "two-class" system common to both the South Seas and America.

TEMPERATURES IN EUROPE DURING THE TERTIARY PERIOD.—A paper with the title "Der Einfluss der variablen Erdbahnelemente auf das morphogene

Warmebild Europas im Tertiär" is published in the 1924 year-book of the Academy of Sciences, Vienna. The author, M F Kerner-Marilaun, read the paper before the mathematical-physics class, and he deals with the influence of variable elements in the earth's orbit on the temperature distribution in Europe in tertiary times. Von Spitaler's calculations of temperature in pure land and sea climates were used to establish regions with extreme temperatures in tertiary Europe. For winter temperatures, values calculated earlier by the author were employed, while special formulæ were developed to obtain the summer temperatures, and from these results the temperatures for the places of thermal extremes were found. By the variations of flora in horizontal and vertical directions, the regional and zonal fluctuations of temperature caused by astronomical variations can be traced. It is not always possible to trace the influence of each heat wave in an oceanic climate, because other influences may mask the changes to be examined.

THE ORIGIN OF CONTINENTS—In *Die Naturwissenschaften* for July 31, Dr Otto Ampferer of Vienna discusses in detail the various possibilities arising out of the distribution of the continents. He accepts Wegener's conception of the sial and sima layers, but believes that there are probably more than two layers of different density, and that in particular a third layer, intermediate between sial and sima, may underlie the continents. If vertical movements alone are postulated, then the oceans may be due to simple sinking, either by bending without fissures, or by in-breaking with bordering faults. This corresponds with the requirements of the contraction theory, but it is pointed out that expansion would lead to a similar result, the continents being then due to relative uplift. The existing evidence of both compression and tension in the earth's crust implies that both processes have contributed to some extent at least. However, the tectonic study of mountain ranges has proved beyond doubt that very large horizontal displacements have actually taken place, implying that extensive regions of the continents have been bodily moved. Vertical movements alone cannot explain these extraordinary thrusts, and Ampferer believes that, in addition, horizontal movements, independent of those arising from compression, must be postulated. He shows that Wegener's displacement theory involves the difficulty that it provides no possibility of explaining two absolutely opposed processes: the first, the compression of the original uniform shell of the earth into a primeval continent collected around Africa; and the second, the subsequent break-up and dispersal of the land area into the continents of to-day. Wegener suggests for the cause of the dispersal only relatively feeble external forces. Ampferer insists that some entirely different kind of phenomenon is necessary. He does not discuss the recent views of Joly, Holmes, or Evans, all of whom have contributed to a possible solution, but he favours the idea that under-streaming currents within the earth may be responsible. Ascending currents beneath the continents would raise and split them, and carry the fragments in all directions; whereas Wegener's forces would lead to a definite direction of drift.

RAINFALL IN AUSTRALIA—The rain map of Australia for 1924, which is published by the Commonwealth, shows the distribution of precipitation for each month, and contains also a detailed map of the annual fall indicating excess and deficiency compared

with the normal. The year was similar to 1923 in its marked rainfall contrasts. In the north-western part of the continent there were severe drought conditions, while on the other hand, in eastern Australia, including Tasmania, there was abundant rain, making the year one of the most favourable on record for pastoral and agricultural interests. Winter was comparatively dry, but in August widespread rainfall set in and continued for three or four months. In December the rains decreased, and harvesting conditions were ideal in most parts. Over the continent as a whole, 27 per cent of the area had a rainfall above the annual average. This compares with 22 per cent in 1923, 21 per cent in 1922, and 63 per cent in 1921. In 1924, however, the excess above the normal was almost entirely confined to the eastern part of the continent.

TERRESTRIAL MAGNETISM—Several new propositions with regard to terrestrial magnetism are announced in the June issue of *Terrestrial Magnetism and Atmospheric Electricity*. The fact that magnetic storms increase in frequency with the sun-spot numbers has been known for some time, but Dr. A. Podder, of the Irkutsk Observatory, shows from an examination of the records of that observatory for the past thirty years that storms are more frequent in March and in September than in any other months, and traces this to the passage of the earth in those months through the plane in which the centres of maximum activity of the sun are situated. He finds there is also a daily variation in the frequency of storms, which is independent in character of sun-spot number and of season. During each storm the deviation of the compass is reduced, the dip increased and the horizontal component of the magnetic field decreased. With regard to "sudden commencements," Dr. L. A. Bauer finds from an examination of the records of 30 disturbances that while there may be cases in which they occur simultaneously at all points, the speed of propagation may be so low as 1000 kilometres per second along parallels of latitude and only 100 kilometres per second from the magnetic equator towards each magnetic pole.

THE PHYSICAL NATURE OF THE CORONA—The various theories as to the nature of the solar corona are discussed by Dr. W. Anderson in the *Zeitschrift für Physik* for Aug. 1. Taking into account the amount of light emitted by the corona, and the amount passing through it from the photosphere, he estimates that, if more than fifty per cent of the gravitational force acting upon the material of the corona is to be balanced by the radiation pressure, the total mass within one solar radius of the sun's surface must be less than 10^{18} grams. The theory of C. Fabry, which ascribes the continuous spectrum of the corona to diffusion of solar light by gases as in Raleigh's theory of the spectrum of light from the sky, does not explain the absence of Fraunhofer lines in the coronal spectrum, and is in other ways unsatisfactory. The hypothesis that gaseous particles fluoresce under the influence of the light of the photosphere is rejected, since the spectrum appears to be truly continuous, with a few bright lines, and not to be due to the superposition of a number of banded spectra due to fluorescence of different gases. It is very improbable that the coronal light is due to bombardment with corpuscular radiation of radioactive origin. The difficulty with the electron gas theory of the corona is that it requires a positive charge on the sun equal to the negative charge of the corona, and that under these conditions the extension of the corona could only be small. This difficulty may possibly be got over by assuming that Coulomb's law of electrostatic force ceases to hold for large distances. It is possible to test the universe square law of

gravitational force for large distances, but this is not possible in the case of electrostatic force, and it may perhaps fall off in such a way as to account for the structure of the corona.

SHEET GLASS PRODUCTION—Prof. W. E. S. Turner describes the modern production of sheet glass in a paper published in the *Journal of the Royal Society of Arts* for July 24. For many years, until quite recently, glass used for sheet had the composition SiO_2 72-74 per cent, CaO 12-14 per cent, Na_2O 12-14 per cent, the latter being mainly derived from soda ash. In two of the automatic processes recently introduced, a softer glass has been employed containing a higher percentage of sodium oxide. The presence of magnesia retards devitrification and tends to make more uniform the rate of change of viscosity. In Lubbers' process, the glass is melted in a large tank and is removed in 500-570 lb lots in an iron ladle. This is poured into a hot "drawing pot," really a shallow fireclay dish, and a "drawing head" is lowered in. On elevating the latter the glass is drawn up into a cylinder, which may attain a length of 36 ft and is usually 30 in in diameter. The cylinder is then split and flattened in the usual manner. Methods are now in use in which sheet glass is drawn directly without necessitating the formation of a cylinder. Two such processes are described. The Libbey-Owens process was inspired by the inventor watching a paper-making machine; molten glass is drawn from a trough over rollers on to a "flattening table," where it is annealed. In the Fourcault process, molten glass is drawn vertically upwards through a slot. The manufacture of plate glass dates from 1665 and the process has remained practically unchanged; the modified process used by Ford for manufacturing wind-screens for motor cars is described.

EXPLOSIVE GAS MIXTURES—Papers 8, 9 and 10 of the Safety in Mines Research Board deal with the very important matter of the ignition of firedamp (H.M. Stationery Office, Nos 8 and 9, 6d each, No 10, 4d). The work embodied in the reports has been carried out by Dr. R. V. Wheeler and co-workers. Papers 8 and 9 are intimately connected. It is shown that the mixtures of methane and air most readily ignited by a sustained source of heat are those containing an excess of oxygen. Such mixtures require a source of heat at a lower temperature and, moreover, a shorter period of contact (provided, of course, the temperature is above the ignition point). With other paraffin hydrocarbons (e.g. ethane, propane, butane, pentane) the mixtures most readily ignited by a similar source of heat contain an excess of combustible gas. The ease of ignition of paraffin hydrocarbon-air mixtures increases as the hydrocarbon series is ascended; the lag on ignition decreases under similar circumstances. Report No. 10 deals with firedamp explosions within closed vessels and the effects of turbulence, the latter being studied in relation to the maximum pressures produced and the time taken to attain the maximum pressure. Whereas considerably enhanced pressures can be obtained from weak mixtures of methane and air when they are turbulent, the most explosive mixtures (9-10 per cent methane) are not much affected even by extreme turbulence. The maximum pressure obtainable from any quiescent mixture of methane and air, initially at atmospheric pressure, when exploded in a closed vessel is about 105 to 110 lb. per square inch. The effect of turbulence is to increase this maximum pressure by about 4 per cent. On the other hand, with both weak and strong mixtures the effect of turbulence is greatly to increase the rapidity with which the maximum pressure is attained.

The Heating of Rooms.¹

THE Fuel Research Board has published a useful paper on the heating of rooms by Mrs Margaret Fishenden and Mr. R. E. Willgress. A room of about 4000 cub. ft. capacity, shaded from direct sunlight, and possessing a hearth and flue, was used. Air-heating was obtained by hot-water radiators or by luminous batwing gas flames placed about 6 inches above the floor. The air movement was then about $\frac{1}{2}$ to $\frac{1}{4}$ ft. per second. After entering the test-room, the two observers engaged in sedentary employment for at least an hour before the comfort feelings were noted.

With no source of radiation, a comfortable feeling of warmth corresponded with a temperature of air and surrounding surfaces of 65° F. One of 62° F. was too chilly, and 68° F. slightly too warm. This is the range for minimal evaporation of a resting clothed man in still air. Increased evaporation begins at about 73° F., and 72° F. was the temperature at which distinct discomfort was felt.

When the walls and floor were slightly cooler than the air, the air to give comfortable warmth had to be warmer, e.g. 66° F. for walls, etc., at 63° F., and 67° F. for 61° F. On the other hand, with walls, etc., at 66° F., 67° F., air temperatures of 63° F., 61° F. sufficed. When the walls, etc., were more than a degree or two colder than the air, chilliness combined with stuffiness was felt, but with the walls a few degrees in excess of air temperature, very comfortable conditions were felt. With the flue blocked, a feeling ensued of heaviness, airlessness, and blunted mental energy. Even with the flue open, air-heating was found to be far from ideal for mental work. The authors concluded that a sunless room cannot be rendered entirely pleasant by air-heating alone. They found that variation of wet bulb temperatures from 51° F. to 57° F. for a dry bulb of 65° F. had no effect on the comfort feeling.

With air-heating and air-flows of 2, 4, 6, and 8 ft. per second over the entire position of the observer, dry bulb temperatures of 69°, 72°, 75°, and 76.5° F. were needed to sustain comfort. The corresponding mean wet bulb temperatures were 60°, 62°, 64.5°, and 66.5°. As was pointed out by the inventor, the ratio between the rate of cooling of the kata-thermometer and the rate of cooling of a clothed man increases as the air velocity increases, because clothing exercises an increasingly important shielding effect as the air velocity rises. Draught exceeding 4 ft. per second became annoying, and distracted the attention from mental work.

Ideal conditions conducive to mental work were got in a room with south-west aspect by an air temperature of 64° F. to 68° F. with October-November sunshine and open windows, and a draught of $\frac{1}{2}$ to $1\frac{1}{2}$ ft. per second.

Radiation was studied by means of a modern gas-fire, and by an open wire electric heater placed under the chimney flue. Additional draught could be produced by a gas-ring in the flue; thus $2\frac{1}{2}$ to $4\frac{1}{2}$ changes of air per hour could be had. The air temperature was brought to the desired level, and the subject sat at various distances from the fire. While warm enough at an air temperature of 65° F. without radiation, at 60° F. a mean horizontal component of 30 B.Th.U. per sq. ft. per hour was

required to produce warmth, at 55° F., 75 units, at 50° F. 120 units, at 45° F. 170 units. Radiation figures well below or above these gave chilliness or warmth.

The most comfortable conditions were with 55° F. and adequate radiation, above this a slight feeling of mental lassitude was produced, and below it a feeling of too warm on one side, too chilly on the other. Below 45° F. it was impracticable by a fire to avoid this feeling. The alpine sun may, however, give one in a reclining position 500 B.Th.U. per sq. ft. per second—enough for an air temperature far below freezing point. It is the equable climate of Britain which makes open fires practicable. In countries where the outside temperature remains for months below freezing point, air must be heated, and a closed stove or central heating is used. A low temperature radiator heated by bunsen burners below red heat and 6 ft. square in size was found very pleasant. This is equivalent to wall panel heating, which has been found successful in the Bush building at Aldwych, London.

Two cylinders of water 8 inches in diameter and one-third the height of an average man were used, one of bright polished copper, the other coated with lamp black, and the effect of clothing on the loss of heat from these cylinders was studied. The water was kept stirred. In still air, a single woollen vest reduced the heat loss to 66 per cent. of the unclothed black body, with an additional white serge garment to 45.5 per cent., with further black serge coat to 38.5 per cent. In a draught of 2 ft. per second the reductions were to 60, 42, and 36 per cent., and in one of 6 ft. per second to 48.5, 32, and 25.5 per cent. respectively. The three garments together cut down the absorption of radiation to 20 per cent. of that which was absorbed by the unclothed black calorimeter.

The last part of the paper deals with the cost of heating. The hot-water radiator with coke boiler is most economical for continuous heating of a small room (1000 cu. ft.), or for a larger room (4000 cu. ft.) where people cannot gather round a fire. An open fire is cheapest for the larger room when occupied by a few people who can gather near it, because air-heating is not then necessary. For intermittent heating, the hot-water radiator is cheapest for a small room, and open coal, coke, or gas fire for a larger room. "Whatever the method adopted, the cost will be closely allied with the completeness of insulation of the rooms." An air space between two thicknesses of brick and double windows are two suggestions made.

Here we come up against that conflict between stagnant artificial heat and good health which is not considered by the authors, but is established both by physiological research and the experience of open-air life. We should aim at the least degree of heating with which we can do sedentary brain-work or skilled hand-work in comfort, and the maximal amount of window ventilation. If clothes were adjusted to individual need in offices and factories, and the feet kept warm by small local units of heat, far less air-heating would be necessary, and far more window ventilation made possible, and in this way, and by abolishing smoke pollution and securing more sunlight, catarrhal infections would be reduced. It is the open-air life, and not sheltering indoors in heated rooms, that keeps catarrhal diseases off and the general health up.

L. H.

¹ Department of Scientific and Industrial Research. Fuel Research Board. Technical Paper No. 12. The Heating of Rooms; a Comparison of the Costs of different Methods on the Basis of Warmth Comfort. By Dr. Margaret Fishenden, assisted by R. E. Willgress. Pp. iv+48+6 plates. (London: H.M. Stationery Office, 1925.) 1s. net.

Thunderstorms and Other Features of the Weather.

MR. BROOKS has compiled a very valuable monograph on the thunderstorms of the world¹. A "day with thunder" is the unit employed, and records are used from 3265 stations, 2680 being in Europe. Maps show the percentage of days with thunder for the whole year, and for each half-year. It is assumed that thunder can only be heard up to ten or twelve miles, and that on the average it will only be recorded when occurring within six miles of any station. Mr. Brooks shares the general opinion that thunder is not heard farther than about twelve miles, but this distance may frequently be doubled at night, and sometimes tripled.

The maps show six areas of maximum frequency of thunder, Madagascar, Central Brazil, Panama, Southern Mexico, Central Africa, and Java, in which island thunder occurs on 61 per cent. of all days. Areas with thunder on less than 1 per cent. of all days are Greenland, north Iceland, north Norway, the north coast of North America, the Arctic Ocean, and the Antarctic Continent. There are areas of low frequency on the west coasts of North and of South America, and on the west coasts of South and North Africa; the latter area extends across the Sahara into Arabia, the other three do not extend far inland, but all of them go a long way out into the ocean. All these regions are on the east side of anticyclonic areas in positions where winds from a polar direction keep the surface temperature cool; they are also in regions of cool ocean currents, and, though Mr. Brooks does not actually point it out, these may have something to do with the low thunderstorm frequency; the Peru, the Benguela, the California, the Canaries, and the Labrador currents are all reflected in the isobronts; even the small cool current down the Korean coast shows its effect.

A very interesting map is given showing what percentage of thunder occurs in winter in western Europe; the 30 per cent. line extends down the Norwegian coast, embraces practically the whole of the British Isles, and crosses Brittany and the north-west coast of Spain, eastward the percentage decreases, but north-westward it increases to 75 per cent. for the region of Iceland and the Faroes. Another map illustrates the distribution of thunder over central Europe in July, and shows that the "chief maximum of thunderstorm frequency in Europe extends in a long narrow belt at the base of the northern slopes of the Alps."

It is estimated that over the whole globe 16,000,000 thunderstorms occur per annum, if the average duration is one hour, there are 1800 storms occurring at any one time, if there are approximately 200 flashes per hour in a severe temperate, or an average

¹ Air Ministry Meteorological Office Geophysical Memoirs, No. 24. The Distribution of Thunderstorms over the Globe. By C. E. P. Brooks (M.O. 254d) Pp. 145-164+4 plates (London H.M. Stationery Office, 1925) 2s. net.

tropical storm, there will be 100 flashes per second over the globe. The number thus estimated by Mr. Brooks is of the same order as the frequency of atmospherics, which may all, therefore, be possibly due to lightning. In further sections are discussed the variation of thunder with season and with latitude over both land and sea, the diurnal variation and the effect of height on thunder frequency.

Mr. Brooks's work is a most important addition to the literature of the subject, and is one that no meteorologist can afford to be without; it will also be of value to those who take an interest in thunderstorms without being themselves meteorologists.

Dr. Sen² has collected the records on wind components that have been published in the *Geophysical Journal*, and his paper is illustrated by tables and diagrams. The south-north and west-east components of the wind are discussed in relation to the annual and diurnal variation; maps show the averages of the gradient, the gradient wind, and the resultant wind for each month, and the growth of convection winds in summer—land and sea breezes—is investigated.

The scope of Mr. E. V. Newnham's work³ is best explained by the opening paragraph. "The object of this classification is to provide a ready means for discovering whether the conditions prevailing over the North Atlantic and Europe at any time bear any resemblance to situations that have arisen in the past at about the same time of the year, and, further, to bring into evidence any distributions of pressure which tend to recur and may be regarded as genuine types, and to determine the seasonal variations of such types." The position of anticyclones is the basis of the classification; the region between latitudes 30° N. and 80° N., and longitudes 30° E. and 70° W., has been divided into ten areas to each of which a letter has been assigned, the position of anticyclones is shown by the capital letters of the areas over which they occur, while the position of depressions is shown by small letters.

The work must have involved an immense amount of labour; Table III gives each of the 5478 days of the period concerned with the pressure distribution found on each, while Table IV gives an index of the pressure distributions with the dates on which each occurred. It will prove of great assistance to those who are interested in investigating types of weather and changes in types, the summaries are in an extremely convenient form for reference.

C. J. P. C.

² Air Ministry Meteorological Office. Geophysical Memoirs, No. 25: Surface and Geostrophic Wind Components at Deerness, Holyhead, Great Yarmouth and Scilly. By Dr. Sachindra Nath Sen (M.O. 254e) Pp. 165-178+6 plates (London H.M. Stationery Office, 1925) 2s. net.

³ Air Ministry Meteorological Office Geophysical Memoirs, No. 26: Classification of Synoptic Charts for the North Atlantic for 1896-1910. By E. V. Newnham (M.O. 254f) Pp. 179-200+1 plate (London H.M. Stationery Office, 1925) 6s. net.

The International Psycho-Analytical Congress.

(FROM A CORRESPONDENT)

THE ninth international Psycho-Analytical Congress which assembled on September 3-5 at Bad Homburg, Germany, was marked by some interesting features. Unlike its predecessor which met at Salzburg at Easter 1924, under the shadow of Prof. Freud's serious illness, the ninth congress was very happily able to begin its business by sending Prof. Freud a congratulatory telegram on his restoration to health.

As at the last three congresses, dating from 1920,

the year which saw the first re-assembly since the pre-War period, many nations were represented, and by many distinguished names. In his presidential address, Dr. Karl Abraham, Director of the Berlin Psycho-Analytical Clinic, welcomed representatives, who with relatives and visitors numbered about two hundred, from Austria, France, Germany, Great Britain, Holland, Hungary, India, Poland, Switzerland, Russia, and the United States. Dr. Abraham expressed particular satisfaction at

the presence of his American colleagues, who included such well-known workers as Dr. Jelliffe and Dr. Pierce Clark of New York, Dr. Trigant Burrow of Baltimore, and Dr. Isidor Coriat of Boston. The attendance of representatives from France was another sign of the acceptance of Freud's views in countries which have hitherto stood aside.

The most important features to be noted in the movement are the developments of psycho-analytical theory and practice; the increase in the number of constituent societies, and in the membership of these societies, the continuous research work and the increased publication of results; the large amount of clinical work carried on, and the greater general attention given, even if at times in the form of opposition, to Freud's discoveries. The work of the Berlin and Vienna Polyclinics clearly evidences the need for, and appreciation of, psycho-analytic treatment, and it is much to be hoped that before long every country will establish similar clinics, especially so great and important a country as England, which is still, strange to say, without a solitary clinic for this treatment. The valuable help which can be obtained by those sufferers who have found no solution for their difficulties through existing methods of treatment will then be more widely appreciated.

The contributions to the Congress were divided into four sections: theoretical questions, therapeutical questions, clinical matters, and applied psycho-analysis—an arrangement which made for clearness and simplification. Perhaps the sections of the greatest interest, at least to the Congress as a whole, were the two dealing respectively with therapeutical questions and applied psycho-analysis. In the first section, Prof. Freud's paper, a very technical one, on "The Bearing of the Anatomical Differences in Male and Female on the Oedipus Situation," was read by his daughter, Fräulein Anna Freud, who is herself a brilliant children's analyst, practising in Vienna.

Great interest was shown in the paper given by Dr. Ferenczi (Budapest Psycho-Analytical Society), one of the most widely known Continental analysts, on "Counter-indications to Active Psycho-Analytic Technique," in which he dealt with the theme of "active therapy" once more. This subject, which was put forward by him at the Salzburg Congress and created a somewhat sensational effect as a seeming sharp departure from the Freudian technique in treatment, was now dealt with by Dr. Ferenczi for the purpose of pointing out certain misconceptions which had arisen. It was important, he said, to realise that he did not suggest the employment of this "active" technique for all cases under treatment or as the sole method in any individual case, or with rigorous application, but only as *one* method at given times and at an appropriate stage. In respect to his "terminal limit" for the patient's treatment and the complete severance between patient and analyst when such a limit had been reached, a view also put before the Salzburg Congress, Dr. Ferenczi explained that he no longer wished to adhere strictly to such practices, but rather to make use of them only in exceptional situations. It may be said that the general tenor of the paper was in the direction of more elasticity, more modification of previous stringent views, although without any abandonment of basic Freudian principles.

Much the same attitude was expressed in the paper given, in the same section, by Dr. Otto Rank (Vienna Psycho-Analytical Society) on the birth theory formulated by him at the Salzburg Congress, and embodied in his book, "The Trauma of Birth."

He made something of an apologia for his too definite pronouncement of a year ago, making it plain that he no longer regarded the birth-situation (the first great trauma) as the only significant one in the shaping of the individual's destiny, but as playing a vitally important rôle in the whole psychic drama. In this same section, two more papers of interest were Dr. Alexander's (Berlin Psycho-Analytical Society) on "Neurose und Gesamtpersönlichkeit," and Dr. Pierce Clark's (New York Psycho-Analytical Society) on "The Phantasy Method of analysing Narcissistic Neuroses."

In the fourth section, dealing with applied psycho-analysis, a brilliant paper evidencing deep research, was read by Dr. Géza Róheim (Budapest Psycho-Analytical Society), the well-known Hungarian anthropologist, who, it is interesting to recall, will read a paper before the Royal Anthropological Institute in London next month. Dr. Róheim took for his subject "The Scapegoat," and expounded the origin and significance of the idea of the sin-offering and expurgation among ancient and primitive peoples. Dr. Theodore Reik (Vienna Psycho-Analytical Society) gave a paper on "The Origin of Psychology," in which he dealt in a masterly manner with the problem of (to give a free translation of the German title) "How do Human Beings come to bother about Psychology?"

Dr. M. D. Eder (British Psycho-Analytical Society) gave a paper on a hitherto little-investigated subject, "A Contribution to the Psychology of Snobbishness," claiming it as appropriate that this theme should be dealt with by a speaker from England, since that country was the classic home of snobbery. He worked out in a very interesting manner the sources and significance of snobbishness, illustrated from actual analytical cases and from the rich material in English literature, especially the work of Thackeray ("The Book of Snobs," "Pendennis"), of Meredith ("Evan Harrington"), and of Thomas Hardy ("A Pair of Blue Eyes").

At the business meeting which concluded the Congress, after re-electing to another term of office the president, Dr. Karl Abraham, and the secretary, Dr. Max Eitingon, to both of whom the Congress expressed sincere gratitude for their past work, an important decision was taken. This was to form an International Commission, constituted from Committees formed in all the individual branch societies, to draw up regulations acceptable to all countries represented in the Association for the admission of practising analysts. For some time past it has been felt that the qualifications demanded from practising analysts differ too widely according to the country concerned and even the individual psycho-analytical society. In some cases the regulations are exceedingly strict, making for assured scientific equipment; in other cases, however, the qualifications demanded are too slight to ensure any genuine knowledge or experience on the part of the so-called analyst, or even that he has subjected himself to a real analysis. It is hoped that the new Commission will be able to frame regulations sufficiently acceptable to create uniformity of qualification, which shall be such as to ensure a high standard in respect of knowledge, training, and personal suitability for psycho-analytic practice.

The business proceedings ended with a debate on the meeting-place for the next Congress. The final choice lay between Italy and England, an invitation to the latter being extended by Dr. Ernest Jones, president of the British Psycho-Analytical Society, and predecessor of Dr. Abraham as president of the International Association. The question of distance

was of importance to the Continental members, and ultimately, by a very small majority, Italy was selected.

In conclusion it is interesting to note that the characteristic feature of this Congress, one that sharply differentiated it from its predecessor, was the absence of dogmatic pronouncement and rigid conception, rather there was an apparent desire to discover how new, or partially new, theories could

be adjusted to already established facts, and a spirit of modification and adaptation on the part of those who earlier had put forward ideas of a somewhat disruptive nature. This attitude, with the important decision already referred to in the direction of uniformity and increased efficiency in psycho-analytic practice, augurs hopefully for future developments in psycho-analysis, both in research and practical therapeutic work.

The Royal Photographic Society's Exhibition.

THE annual exhibition of the Royal Photographic Society at 35 Russell Square, London, W.C.1, remains open until October 24, and admission is free. The scientific and technical sections are numerous, and each contains exhibits of notable interest. The Astronomer-Royal shows "Prism-crossed Grating" spectra of Vega compared with spectra of the carbon arc and a 3-watt electric lamp. The comparison of these spectra gives data from which the temperature of the star may be calculated from the known temperatures of the artificial illuminants. Star spectra enlarged 7.6 times horizontally and broadened 19.5 times by means of a clepsidra apparatus invented by the exhibitor are contributed by Dr W. J. S. Lockyer. Among the aerial photographs are several fine examples by the Royal Aircraft Establishment, and the application of this method of work to archaeological research is well illustrated by Messrs O. G. S. Crawford and A. Keiller, one of whose examples reveals an ancient village site seen through the crops, in Hampshire.

The natural history section is a very large one, and those of the ordinary kind are only mentioned as a group because there is such a great variety of good work. But Mr Oliver G. Pike has endeavoured, with success, to show the action of the wings of birds during certain phases of flight. Presumably these photographs are enlargements from his slow motion cinematograph films shown elsewhere. Among the specimens of cinematograph films are some from the Eastman Kodak Research Laboratory which illustrate some possibilities in the use of colour and form in motion as a means of entertainment and to produce pleasurable sensations by an appeal to the visual sense similar to those produced by music. The kodachrome two-colour subtractive process is used in the production of these films.

The photomicrographs are many and chiefly low power work. Dr G. H. Rodman illustrates the structure of the petiole of the water hyacinth, an aquatic floating plant of tropical America. In another series of 24 sections he shows the character

of the idioblasts which occur in various water lilies. Mr F. Martin Duncan contributes further studies on the cuticular scales of mammalian hairs, which confirm his theory of the importance of their specific characters in the phylogenetic study of mammals. Photomicrographs of several alloys, chiefly alloys of copper, and illustrating flaws and changes produced by various treatments, are contributed by Capt J. W. Bampfylde. Micro-radiography as applied to geology and palaeontology is illustrated by 24 examples by Pierre Goby, who also has four stereo-micro-radiographic pairs showing stereoscopic relief and pseudo-relief. Of natural size radiographs there are many examples.

Among the other examples of the application of photography to scientific investigations may be mentioned shutter test diagrams with full explanations from the optic division of the National Physical Laboratory, and Prof Coker's natural colour transparencies which show the nature of stress under various conditions in models of buildings. The transmission of photographs over telephone wires for practically any distance and in a few minutes is illustrated by the International Western Electric Co., which shows transmitted photographic portraits, landscapes, views of buildings, letterpress, a fingerprint, writing, charts, and a coloured photograph. The perfection of the reproductions is remarkable. Mr Thorne Baker has an example of a picture transmitted by wireless telegraphy. The British Photographic Research Association shows the effect that fuming with ammonia has upon the character of the grain of silver bromide gelatine plates. The selenium density meter designed by members of this Association is shown by Watson and Sons, and in the rather large trade section Chance Brothers show optical glass from its manufacture to the finished lens, and specimens which illustrate the effects of tests for durability, of devitrification, and of the improvements in the quality of dense barium crowns in the years 1915, 1917, 1924, and this year. In the last the colour is practically eliminated and bubbles are scarcely visible.

Oyster Dredging in the Fal Estuary.¹

DR J. H. ORTON, of the Marine Biological Association, presents a useful report on the oyster fisheries of the Fal Estuary, which are managed by the Truro and Falmouth Corporations, being owned by the Duchy of Cornwall. Each dredgerman takes out a licence and is entitled to dredge oysters more than 2½ inches in diameter during the winter months. The proceeds formerly were largely used up in lawsuits, but we judge that they now mainly pay the wages of bailiffs, whose business it is to see that the size regulation is observed. There would seem to be no cultivation of the oysters, no cleaning

of the grounds, no laying of suitable hard material on which the spat can settle (cultch), nothing indeed beyond the relaying of already marketable oysters in private or leased intertidal waters until there are suitable market conditions.

The spat falls in the three years 1922-24 were failures, and, as oysters are usually caught for market in their fourth and fifth years, the fishery is bound to be too lean for most of the 200-300 dredgermen to obtain a livelihood in 1926-29, even if the present year should see a good spat fall. Dr. Orton does not deal with the causes of the bad spat fall, and it is not clear whether there was an insufficiency of oyster larvae, or whether the ground was so muddy that they could not survive when they settled on the bottom.

¹ Summary of a Report on a Survey of the Oyster Beds in the Fal Estuary in November 1924, with Notes on the Biology of the Oyster. By Dr J. H. Orton. (Published for the Falmouth and Truro Corporations.)

We suspect the latter, as so much stress is laid on cultching as compared with the establishment of proper spawning stocks. Further, the small, misshapen, nut-like, rounded oysters, forming 45 per cent. of the stock, are characteristic of dirty ground.

The total stock on the grounds is estimated at about 8 millions, sufficient, if the "nuts" be deducted, to give a catch of upwards of a million a year, while in the last century the average catch was many times as much. Of course, the raising of the catchable size and all sorts of restrictions in the fishing are suggested, but it is questionable, if Dr. Orton's facts be accepted, whether these could do more than keep a limited number of dredgers on the grounds while administrative authorities are seeing whether they will do anything.

Dr. Orton's summary does not tell us the exact condition of the Estuary to-day, but in 1915 the shores and main channel were filthy with mud, detritus, weed, etc., and the real question then seemed to us to be whether money could be found to harrow and cultch selected areas and afterwards to keep them in good order. A careful study of the alterations in land drainage, in mine workings, etc., of the watershed of the Estuary during the last century should show whether this is worth doing at all, and, if it be done, all regulations should be re-examined so that the fishermen should act as their own bailiffs for the new regulations, while their licence fees or royalties would be available for the upkeep of the whole grounds. We feel that it would be best for the two Corporations concerned either to return the fisheries to their owner, or to place themselves in the hands of Dr. Orton, or some other competent person, and carry out his behests.

J. S. G.

University and Educational Intelligence.

ST. ANDREWS—Dr. David Rutherford Dow has been appointed to succeed Principal Mackay in the chair of anatomy in University College, Dundee. Since 1913 Prof. Dow has been lecturer in regional anatomy at the United College and assistant successively to Prof. Musgrove and Prof. Waterston, the Bute professors of anatomy there. His research work in anatomy has resulted in several papers published in the *British Medical Journal* and the *Journal of Anatomy*.

THE East Anglian Institute of Agriculture, Chelmsford, gives details in its Calendar for 1925-26 of some eighty courses which it offers in its departments of agriculture, agricultural biology, agricultural chemistry, dairy technology, horticulture, and poultry and small live stock. It undertakes to prepare students not only for its own certificates and diplomas and those of the Royal Agricultural and Royal Horticultural Societies and the British Dairy Farmers' Association, but also, in conjunction with University College, London, Bedford College for Women, East London College, and Chelsea Polytechnic, for the degrees in agriculture and horticulture of the University of London. The Institute specialises in animal husbandry, and farm economics, dominion agriculture, dairying, and commercial horticulture. It conducts a school gardening class on Saturdays for teachers. The North of Scotland College of Agriculture offers courses for the university degree in agriculture, the national diplomas in agriculture and dairying, a college diploma in poultry-keeping, and a special farmers' course in the winter. A joint committee of the College and the University of Aberdeen controls the Rowett Institute for Research in Animal Nutrition.

Societies and Academies.

WASHINGTON, D C

National Academy of Sciences (Proc Vol 11, No 8, August)—**Edwin B Wilson**. The logistic or autocatalytic grid. Arithmetic and logarithmic probability paper, on which the integrals of certain curves become straight lines, is of value in problems in chemistry, biology, economy and other subjects.—**Nelson W. Taylor and Gilbert N. Lewis**. The paramagnetism of "odd molecules". Evidence of paramagnetism was obtained for chlorine dioxide (in carbon tetrachloride), the free organic radical α -naphthyl diphenylmethyl (in benzene) and in solutions of sodium in liquid ammonia and of thallium in mercury. In the latter solutions an electron is given up by the dissolved metal to the solvent, thus forming a molecule (the solvent) containing an unpaired electron.—**Allan C. G. Mitchell**. The activation of hydrogen by excited mercury atoms. The rate of reaction of mixtures of hydrogen and oxygen in the presence of mercury and exposed to light from a mercury lamp was measured and the effect of addition of argon determined. As the pressure of argon is increased, the reaction-rate decreases.—**Selman A. Waksman**. What is humus? 60-70 per cent. of the organic matter in the soil, including the "humic acids," is soluble in alkalis and precipitated by acids. This portion can be divided into α - and β -fractions which are insoluble and soluble respectively in dilute acids. The α -fraction (or "humic acid") gives the soil its black colour and is derived from lignins and the cells of soil micro-organisms. The β -fraction provides the buffering properties to soils. Peat soils contain largely the α -fraction, while mineral soils contain the β -fraction in addition and often predominating.—**R. L. Moore**. Concerning the separation of point sets by curves.—**Selman A. Waksman**. The soil population. Soil organisms form a biological complex and should be studied as such.—**Ludvig Hektoen and Kamil Schulhof**. The precipitin reaction of thyroglobulin.—**J. B. Collip**. The internal secretion of the parathyroid glands. The secretion can be obtained in a stable form and in a degree of purity and potency hitherto not available. The method used is the dissolution of gland by controlled acid hydrolysis and isoelectric fractionation. The hormone obtained is specific for parathyroid tetany in dogs; its effect is related in the main to calcium metabolism and it causes mobilisation of calcium in the blood.—**Samuel K. Allison and William Duane**. An experimental determination of the critical excitation frequency for the production of fluorescent X-radiation. It would appear that to produce a fluorescent line spectrum, the primary radiation must contain X-rays of frequency at least as great as that of the corresponding critical absorption.—**William Duane**. The calculation of the X-ray diffracting power at points in a crystal. To calculate the density of the diffracting power (or density of electron distribution) from the measured intensities of diffracted beams, certain fundamental assumptions relating to the symmetry of the crystal must be made.—**Carl Barus**. The effect of commutation of impedances on the acoustic pressure produced by paired telephonic systems.—**R. T. Cox and J. C. Hubbard**. A statistical quantum theory of regular reflection and refraction. Large aggregates of quanta are dealt with, and it is assumed that the media traversed by these quanta are continuous, that the quanta travel with the velocity of light and suffer a change of velocity but not of energy on passing from one medium to another.—**R. J. Havighurst**. (1) The distribution of diffracting power in sodium

chloride. The density of electron distribution indicates that along the cube edge and body diagonal there is an alternation of two kinds of atoms; along the face diagonal, all are alike. (2) The distribution of diffracting power in certain crystals. Potassium and ammonium iodide have the sodium chloride structure; ammonium chloride has the body-centred caesium chloride structure. The "electron density" of diamond cannot yet be determined.—A Keith Brewer: Ionisation produced in gaseous reactions. Ethyl alcohol and oxygen are allowed to react, at temperatures below that of ignition, between gold, aluminium, copper, and glass electrodes. It is concluded that ions are formed in the gas layer in immediate contact with the electrode and that positive and negative ions are formed in equal numbers.—G. F. Rouse and G. W. Giddings: Ionisation of mercury vapour by ultra-violet light. When mercury vapour between two plane parallel electrodes is illuminated by light from a hot mercury arc, the ratio of the currents to the two electrodes is approximately that of the areas of the electrodes, indicating photo-electric action. With a water-cooled mercury arc and increased mercury vapour pressure, the currents observed are much greater and their ratio practically unity, indicating true ionisation. No single wave-length of sufficient energy to do this appears to be present, so a cumulative action must occur.—O. K. De Foe and G. E. M. Jauncey: Modified and unmodified scattering coefficients of X-rays in matter. Taking into consideration Compton's change of wave-length with scattering, the ratio of the scattering coefficient of the modified to the unmodified rays is calculated. Experimental results using copper are in fair accord with the calculation.—G. E. M. Jauncey and O. K. De Foe: The energy reappearing as characteristic X-rays when X-rays are absorbed in copper. The methods developed in the previous paper are used, and it is found that the greater part of the energy absorbed goes into the photo-electric ejection of K-electrons.

SYDNEY.

Royal Society of New South Wales, August 5.—G. Taylor, W. R. Browne, and F. Jardine: The Kosciusko Plateau, a topographic reconnaissance. The area investigated extends from "The Créal" at 3000 feet elevation in the east, to Kosciusko (7300 feet) in the west, a distance of 20 miles. As a result approximate contours (form-lines) of 100 feet interval were obtained, and these have been drafted on a map to the scale of half-mile to the inch. Aneroid and Abney-level observations were relied upon for heights. These were supplemented by sketches and photographs which were carefully orientated and annotated.—A. R. Penfold and J. L. Simonsen: The essential oils from the leaves of *Murraya Koenigii* (Spreng), *Murraya exotica* (Linn.), and *Murraya exotica*, var. *ovatifoliolata* (Engler).—J. H. Maiden and W. F. Blakely: Descriptions of sixteen new species of Eucalyptus. Six are eastern species (including one from South Australia) and ten from Western Australia. Two are suggested hybrids, while one has already been described as a variety. Of the eastern species, three are from Queensland, a pale-wooded bloodwood, a northern box and a glaucous ironbark, also from the north. Of the two suggested hybrids, the South Australian one comes nearest to *viminialis*, while one from the Federal Territory is a rough-barked species nearest to *maculosa*. The western species include five mallees, and two fairly large trees, the "Stocking tree" of Kondinin, so called because of its rough bark, sharply defined from a smooth trunk, and the Albany blackbutt, raised to specific rank.

Official Publications Received.

Department of the Interior: United States Geological Survey. Bulletin 757: Geology and Coal Resources of the Axial and Monument Butte Quadrangles, Moffat County, Colorado. By E. T. Hancock. Pp. vi+134+6 plates. 35 cents. Bulletin 772: A Reconnaissance of the Point Barrow Region, Alaska. By Sidney Paige, W. T. Foran and James Gillyly. Pp. v+32+9 plates. 20 cents. (Washington: Government Printing Office.)

The Royal Technical College, Glasgow. Calendar for the One Hundred and Thirtieth Session, 1925-1926. Pp. xxix+408. (Glasgow.)

The Stratigraphy of the Mississippian Formations of Iowa. By Francis M. Van Tuyl. (From Iowa Geological Survey, Vol. 30, Annual Reports 1921 and 1922.) Pp. 33-374+6 plates. (Des Moines: Iowa Geological Survey.)

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 33: Perthshire Tectonics; Loch Tummel, Blair Atholl and Glen Shee. By E. B. Bailey. Pp. 671-698+1 map. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 4s.

Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 3, No. 23. On the Cardinal Function of Interpolation-Theory. By W. L. Ferrar. Pp. 269-282. 1s. 6d. Vol. 45, Part 8, No. 24: The Electrosynthesis of π -Duotriacontane Dicarboxylic Acid. By Dr David A. Fairweather. Pp. 283-285. 6d. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Diary of Societies.

SUNDAY, SEPTEMBER 27.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (Conference at Balliol College, Oxford), at 9.30 A.M.—B. N. Langdon Davies: The Publisher and Research Libraries.—At 8.30 P.M.—H. E. Potts: Patents and Special Libraries.—H. J. Jeffery: The Imperial Institute: its Work and the Methods adopted in the Library to meet its Special Needs.—Miss A. L. Lawrence, A. J. Mundella, Percy Alden: A Sociological Library.—Miss Clayton, Brig.-Gen. Sir Magnus Mowat, Major W. E. Simmett: Transport Intelligence and Publicity.—Sinclair Wood: Research as the Basis of Advertising.

TUESDAY, SEPTEMBER 29.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—Sir Neville Wilkinson: Decoration in Heraldry.

THURSDAY, OCTOBER 1.

FARADAY SOCIETY (at Oxford).—Discussion: Photochemical Reactions in Liquids and Gases.—At 3.30-5 and 5.30-7.30.—Part I. Einstein's Law of Photochemical Equivalence.—Prof. A. J. Allmand: Introductory Paper.—Prof. F. Weigert and Dr L. Brodman: The Verification of the Einstein Photochemical Equivalent Law in a very Simple Photosensitive Liquid System.—Prof. Chr. Winther: The Relation between Quantum Sensitivity and Intensity of Radiation.—Prof. J. Rice: Note on the Radiation Theory of Chemical Reactions.—Prof. L. S. Ornstein: Note on the Influence of Radiation on Chemical Reactions.—Prof. D. Berthelot: The Law of Photochemical Equivalents and the Place of the Quantum Theory in Relation to Atomic Theory and Energetics.—Prof. P. Lasareff: Relations between the Velocity of Photochemical Reactions and Wave Length.—Prof. O. Stern: On the Transformation of Atoms in Radiation.—General Discussion.

CHILD-STUDY SOCIETY, at 6.—William Platt: The Child's Innate Feeling for Music.

FRIDAY, OCTOBER 2.

FARADAY SOCIETY (at Oxford).—Discussion: Photochemical Reactions in Liquids and Gases.—At 10-1 and 2.30-5.—Part II. On the Mechanism of Photochemical Reactions.—Prof. M. Bodenstein: Introductory Paper.—Prof. J. Franck: Elementary Processes of Photochemical Reactions in Gases.—Dr L. Chapman: Some Conclusions from Recent Work on Photochemistry.—Prof. H. S. Taylor: Photosensitisation and the Mechanism of Chemical Reactions.—E. J. Bowen: The Dissociation Theory and Photochemical Thresholds.—Prof. Chr. Winther: Dielectric Constant and the Speed of Photochemical Reactions.—R. O. Griffith and A. McKeown: The Photochemical and Thermal Decomposition of Ozone.—Dr E. B. Ludlam and W. West: The Electron Affinity of the Halogens.—W. Taylor: The Physical Antecedents of the Photo-activity of Chlorine.—Prof. W. Albert Noyes, Jr.: The Formation of Polar Compounds by Photochemical Reactions.—Prof. von Halban: Absorption of Light in Solutions of Electrolytes.—Dr H. Kautsky: On Chemiluminescence.—Prof. C. Berthoud: Photochemical Sensitisation.—Miss C. E. Blaker: Flame Spectra and Chemical Reactions.—W. J. van Dyck: The Bequerel Effect on Copper Oxide Electrodes.—Prof. J. Perrin: The Photochemistry of Fluorescent Solutions.—Prof. E. Bauer: The Photolysis of Methylene Blue Sensitised by Zinc Oxide.—Prof. A. Coehn: The Influence of Moisture on Photochemical Reactions in Gases.—Prof. I. Plotnikow: (1) Concerning the Fundamental Laws of Photochemistry. (2) Photochemical Reactions and Methods of Measuring them.—Prof. N. R. Dhar and B. K. Mukerji: (1) Einstein's Law of Photochemical Equivalence, (2) The Mechanism of Photochemical Reactions.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.

JUNIOR INSTITUTION OF ENGINEERS.—H. Bishop: Problems of Broad-casting.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton).—Conference on Smoke Abatement.

SATURDAY, OCTOBER 3.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton).—Conference on Smoke Abatement.

SUNDAY, OCTOBER 4.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton).—Conference on Smoke Abatement.



SATURDAY, OCTOBER 3, 1925.

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Research on Foot-and-Mouth Disease.

SINCE Loeffler and Frosch in 1897 reported the striking fact that the fluid from the vesicles which form the main outward lesion of foot-and-mouth disease in bovines, could, after dilution with water, be passed through kieselguhr filters without suffering loss of potency, it has been customary to regard the virus of this, perhaps the most contagious of all animal diseases, as belonging to the group of ultra-visible or filter-passing viruses. This demonstration by Loeffler and Frosch was, indeed, the first indication that an animal disease might be associated with a virus the minute size of which permitted it to pass with ease through filters which retained the ordinary microscopic bacterial forms.

On the Continent, especially in France, Germany, and Holland, where foot-and-mouth disease has long maintained a strong foothold, experimental research has been very intensely and continuously prosecuted, largely with a view towards the elaboration of specific methods of prevention and cure. Though much information with regard to the properties of the virus emerged from these investigations, it cannot be said that any decisive solution of the problem of prophylaxis was reached which would be applicable, at any rate, to a country such as Great Britain, which is liable only to occasional outbreaks readily controlled, as a rule, by wholesale slaughter of affected animals and contacts. Further, the accumulated research data have been to some extent of uncertain quality, probably because of the expense involved in carrying out experiments on bovines on a sufficiently grand scale. It came, therefore, as something of a surprise when Waldmann and Pape in 1920 showed that guinea-pigs could be infected with the virus of foot-and-mouth disease. Loeffler's earlier results in this connexion had been negative and the non-susceptibility of small animals had long been regarded as a *chase jugée*.

The new knowledge, as might have been expected, immediately opened up a new and readily exploitable field for further experimental investigations of the foot-and-mouth virus. In April 1924, Frosch and Dahmen, working in Berlin, announced that they had succeeded in cultivating the virus through many generations on an artificial medium and that by a photographic process they had been able to render the virus visible.

It was at this juncture that the Ministry of Agriculture in Great Britain, faced with the severe and continuing prevalence of foot-and-mouth disease in the country, took the enlightened step of appointing a research committee of ten medical and veterinary experts, with Sir William Leishman as chairman, "to initiate, direct and conduct investigations into Foot and Mouth disease either in this country or elsewhere,

with a view to discovering means whereby the invasions of the disease may be rendered less harmful to agriculture." The first progress report¹ of this research committee has just appeared. It contains no dramatic discoveries, but there is abundant evidence of carefully conducted work leading to decisive conclusions in regard to many hitherto obscure points connected with the properties of the foot-and-mouth virus. So far, the research has been conducted in two establishments, at the Lister Institute, where several workers specially engaged by the committee are being directed by Dr. J. A. Arkwright, a member of the committee, and at the Ministry's laboratories at New Haw, Weybridge, where the work is under the immediate supervision of Sir Stewart Stockman.

Both groups have been working on very similar lines, and both have been employing the guinea-pig as the test animal with great success. The method of choice for inoculating this animal with the foot-and-mouth virus is the intracutaneous, in the hairless pads of the hind feet. In twenty to twenty-four hours redness and swelling at the site of inoculation give place to extensive formation of vesicles locally, and this is followed by generalisation of the virus throughout the body, as evidenced by the presence of minute vesicles in the fore feet and tongue and by the infectivity of the blood. The energies of the workers were devoted in the first instance to traversing the claims of Frösch and Dahmen, but with the exception of one or two results of dubious interpretation, no confirmation whatever of the claims of the German workers was obtained. In Germany also, Frösch and Dahmen's claims do not appear to have received any acceptance. It has been apparent, in fact, that the virus tends to die out rapidly, in a matter of hours, when kept at 37° C. on a variety of artificial media. Low temperatures, on the other hand, have favoured its survival.

Always, therefore, with the view of ultimate successful culture, efforts have been concentrated on testing the most suitable conditions for survival of the virus at a temperature of 37° C., and it has been found, for example, that in phosphate solution of pH 7.6 the virus can remain active for four or five days at 37° C. The virus shows a surprisingly high resistance to chloroform and alcohol. In 60 per cent. alcohol, for example, it preserves its potency for eighteen hours at room temperature, while organisms like *B. coli* and *S. pyogenes aureus* are killed in one minute under the same conditions.

Many attempts have been made to infect with the virus other small animals such as rats and mice. Accurate knowledge on this point was desirable, in

view of the obscurity that not infrequently surrounds the paths of dissemination of foot-and-mouth disease. White rats, wild rats, white mice, and house mice only very occasionally give evidence of susceptibility to experimental inoculation. On the other hand, the long-tailed field mouse (*Apodemus sylvaticus*), twelve of which were tested, could be infected with ease. No evidence has emerged, however, to show that, either under laboratory or field conditions, foot-and-mouth disease can spread among these small animals.

Recently the Cattle Testing Station at Pirbright has been adapted for experimental work with cattle, sheep, and pigs, every precaution being taken to prevent the entrance or escape of infection. At this station, only, will such experiments be permitted. While research on foot-and-mouth virus with the guinea-pig as test animal is proceeding at approved institutes, the new experimental station will prove a most valuable adjunct for the final testing of varied material on bovines.

The People of Europe.

Racial Realities in Europe. By Dr. Lothrop Stoddard.

Pp. v+252+3 maps. (London: C. Scribner's Sons, 1924.) 12s. 6d. net.

READERS of Dr. Stoddard's "Rising Tide of Color" or his "Revolt against Civilisation" will know what to expect of the essay at present under notice. "More and more we are coming to realise the fundamental importance of race in human affairs" (p. 3); and the superficial similarity of the civilisation of European countries should not obscure the racial differences between their populations. Climate and soil may account for much, but "are not so universal in their effects as race, which subtly but inevitably influences every phase of human existence" (p. 5). Since on Dr. Stoddard's race-map, accepted without change from Madison Grant's "Passing of the Great Race," "we see a Europe inhabited by three races [Nordic, Alpine, and Mediterranean], Europe's seemingly tangled history grows much simpler, while present-day conditions become more understandable" (p. 5): especially as "Europe is a striking example of the persistence of race" (p. 8), and "even in those regions where racial mixture has been most prolonged and general we find populations not fused into new intermediate varieties with harmonious, stably blended qualities but composed of obviously mixed individuals"—a rather ambiguous phrase—"most of whom can be classified as belonging mainly to one or other of the ancestral types" (p. 9). The reason given for this is "another law of races—the tendency to breed out alien strains when these are not too numerous, so that such strains ultimately vanish, and never reappear in the stock." It is argued

¹ First Progress Report of the Foot-and-Mouth Disease Research Committee. Ministry of Agriculture and Fisheries. (London: H.M. Stationery Office, 1925.) 1s. 3d. net.

that since "these three races differ markedly from one another, not merely in physical appearance, but also in intellectual and emotional qualities" (p. 6), circumstances such as war or industrialism, less favourable to one race, or more so to another, produce the profound social effects which we know, by altering the racial composition of the peoples exposed to them; and the citizens and statesmen momentarily concerned with understanding and alleviating the troubles that ensue, are warned to take account of these anthropological factors, and will disregard them at their peril.

So long as the argument remains in general terms of this kind, it may claim general concurrence. It is only when this kind of applied anthropology begins to be applied to particular cases, that difficulties and objections occur. Even if it be granted that "practically pure-blooded Alpines" are really to be found, for example (as Dr. Stoddard says, p. 15, cf. 170) in "the early Russians" and "the other Slav tribes," do the "Alpine qualities of tenacity, instructive solidarity, and dogged endurance," that "very passiveness" which "has helped to give them the ultimate victory," quite explain the process by which the Slav peoples imposed themselves on the large areas of eastern Europe during their historic periods of migration? And were the "early Russians" or any other Slavs "practically pure-blooded Alpines" at all, when they entered those regions? And if they were, how does Dr. Stoddard know this? Ripley, whose racial theories Dr. Stoddard follows in the main, says that the Alpine type "becomes less pure in proportion as we go east from the Carpathians across the great plains of European Russia" ("Races of Europe," p. 128). In the same way, is it through the "instinctive solidarity" or the "very passiveness" of Alpine temperament that "the Balkan peoples, who are of course mainly Alpines, are always quarrelling and fighting among themselves" (p. 15); and further, in what sense are the Bulgarians "mainly Alpine," or were their Finnish ancestors from far up the Volga themselves "mainly Alpine," and if so, once again, how does Dr. Stoddard know?

In spite of their "tenacity, instinctive solidarity," and so forth, Dr. Stoddard does not wholly approve of "Alpines"; at all events he says (p. 16) that this race "has contributed little that is truly great to politics, art, or ideas," and that "the total absence of Alpine blood in the British Isles is undoubtedly one of the chief reasons for the high qualities of its inhabitants." It is comforting to be assured of our high qualities, still more to learn that there is such a simple reason for them—though it is to be hoped that no British reader of "Racial Realities" will so far practise applied anthropology as to knock on the head as an alien enemy the next Alpine he meets. But, once

again, how does Dr. Stoddard know? Still more surprising, though no less complimentary to ourselves, is his insistence on our "predominantly Nordic" quality, and his association of Scotland with England in this respect, in contrast with Wales and Ireland. If "Nordic" in this context means the same thing as in the chapter on the "Nordic North," described as making Scandinavia "to-day the brightest spot on the Continent of Europe," does it mean a group of mental qualities, or a homogeneous physical type? Unless it means both of these, what becomes of Dr. Stoddard's thesis of the coherence of physical types with mental qualities? Even in Sweden there are only about 54 per cent of pure blonds.

The truth is, that the three-race theory of European ethnology, popularised both in Britain and in the United States by Ripley's brilliant "Races of Europe" some twenty-five years ago, needs a good deal of supplement and qualification before it can be applied to modern nationalities in the way Dr. Stoddard and other recent writers, mostly American, propose. Not only has there been, as Ripley himself frankly admitted, a great deal of interbreeding—so that "in the greater number of cases no invariable association of traits occurs" ("Races of Europe," p. 105), but a chaos of dysharmony—but this interbreeding has in all probability gone so far as to permit the establishment of well-defined secondary types; the so-called "prospectors" along ancient zones of contact between Alpine and Mediterranean populations, and their northern counterparts, the "beaker-folk," as interpreted for example by Sir Arthur Keith, along the margin between Alpine and Nordic areas. There is also cumulative evidence of the persistence of very ancient strains, linking the men of the Plynlimmon moorland with Aurignacian man, the early inhabitants of the Upper Danube basin with peninsular Italy, and so forth, in a fashion which complicates the interpretation of all brunet-longheaded "races." It has also to be remembered that all the three "great races" are themselves abstractions and generalisations from observed coherences or associations of a few easily recognisable characters—headform, pigmentation, and the like—which are observed, however, in infinitely varying degrees in a vast number of individuals. Among Alpines, for example, and in respect of headform alone, there is marked difference between the Cevenole, the Tyrolese, the Albanian, and the Armenoid types, and some reason already to believe that concurrent processes of differentiation and dispersal are recognisable, around a geographical centre in the Near East, which may turn out to be a cradle historically.

What has to be remembered, in the writings of Dr. Stoddard, Madison Grant, and others, is that, as so often

in the past, anthropology has had its opportunities made for it by the political situation. Some of us can remember Max Müller's contributions to the literature of the Russo-Turkish War of 1878, some even the controversy opened by de Quatrefages in his pamphlet "La Race Prussienne." A more recent example is Houston Chamberlain's version of the "racial realities" of Europe - before - the - War. Latterly, the practical difficulties of Americanising large masses of immigrants, from southern and eastern Europe, have led to desperate remedies, and the need to justify them before both American opinion and that of European countries; and this emergency, like all such, has come at a particular phase of anthropological discovery and ethnological theory. But between the canny criticisms of modern European temperaments and predicaments, which are the really interesting part of Dr. Stoddard's book, and the theoretical explanation which he offers us in his diagram of European race-distribution, there are weak links. The kingdom of truth suffereth violence, and the violent take it by force. Over-simplified as it is, Dr. Stoddard's masterkey is a skeleton key; if it turns the bolt, it is not by fitting the wards.

J. L. M.

The Investigation of Colour-Vision.

Colour-Blindness. with a Comparison of Different Methods of Testing Colour-Blindness. By Dr. Mary Collins. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xxxi + 237. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1925.) 12s. 6d. net

THAT theories are useful servants but bad masters is borne out by a study of this book. It embodies "the results of research on red-green colour-blind subjects," and "the tests were carried out unbiased by any preconceived theory and no rigid classification was attempted during the experiments themselves." A mass of observations on ten excellent subjects, eight being students attending the graduating course in experimental psychology, and two science students, has been accumulated. All will admit that such material is of great value, but that alone it is unlikely to afford an explanation of the complex problem under investigation. Its ultimate value will depend upon the deductions drawn from it, and these must necessarily involve theoretical considerations which may support or be adverse to previous theories. In this respect it is essential that the investigator should be fully cognisant of the facts which have been elicited by previous observers, whether they support any such theory or not.

The author states that, "as the facts accumulated, the explanation stood out clearly that the subjects were not all suffering from total blindness to red and green, and that in their inability to discern these colours they could be graded as in a scale." Further, "one other interesting result which emerged from the tests was the indication of the existence of two neutral bands—one in the blue-green region of the spectrum, the other beyond the spectrum in the complementary purple." On the first point Dr. Drever says, in the introduction, "This highly significant fact would seem to involve some modification of most existing colour theories"; on the second point, "Perhaps nothing could throw into clearer relief the inadequacy of a study of colour-blindness based on the spectrum, or the dangers lying in wait for the theorist who fails to distinguish between physical colour and physiological or psychological colour."

The reader could scarcely deduce from these remarks that both facts have long been well known. So long ago as 1895, Sir William Abney, in his Tyndall Lectures at the Royal Institution, demonstrated the "neutral band" in the purple. "The green, he calls white, as he also does the purple" ("Colour Vision," p. 71, 1895). *Pace* Dr. Drever, these are the observations of a physicist, who worked almost entirely with the pure spectrum. It is, in fact, an immediate deduction from the Young theory, for if the green appears white to the colour-blind person, it is obvious that its complementary purple must also appear white. Further, it should have been well known to the author and to Dr. Drever that Abney long ago actually measured the amounts of the deficiencies in terms of the Young theory in different observers (see especially Abney and Watson, *Proc. Roy. Soc., A*, 88, 410, 1913), thus fully recognising degrees of the defect.

The author's opening statement that "the study of colour-blindness has been somewhat retarded by the concomitant study of colour theories" is really astounding. It may be true that "the majority of investigators have started out unduly biased by their favourite theory, and have examined colour-blinds from this prejudiced standpoint," but it cannot be doubted that most of the facts of colour-blindness have been elicited by these observers, and that the contentions of the supporters of the Young and Hering theories acted as a great impetus to the study of the subject. It is true that the psychologically inaccurate nomenclature of adherents to the Young hypothesis, *e.g.* "red-blind," "green-blind," etc., has led to much confusion. Even so, let him who is without sin cast the first stone. We have no reliable knowledge whatever as to how a colour-blind person actually sees the colour of the spectrum; yet Dr. Drever, a psychologist, writes: "The red-green blind sees blues and yellows. Hence a yellowish-

red or a yellowish-green will be seen as yellow. . . Purples will be blue, if there is sufficient blue in them to be apprehended . . . The results obtained by Dr Collins enable us to form a fairly accurate idea of the colours of this world."

Dr. Drever says that "colour-vision is primarily the field of the psychologist," but natural phenomena are not divided into these water-tight compartments. Psychology, except as a mass of philosophical speculations, is based upon physiology, which itself is based on chemistry and physics. The psychologist who is not adequately equipped with knowledge of physics is even less likely to succeed in solving problems of colour-vision than the physicist. We agree that vision, including colour-vision, should be the particular study of psychologists, for upon vision more than upon any other sense the advance of the primates to man depended. Psychologists have contributed far less than physicists and physiologists to our present knowledge of colour-vision, and are likely to continue to do so until they realise that the approach to psychology must be from the biological rather than the philosophical side.

Historic British Scientific Instruments.

Historic Instruments for the Advancement of Science: a Handbook to the Oxford Collections prepared for the opening of the Lewis Evans Collection on May 5, 1925
By R T Gunther. Pp. iv+90. (London: Oxford University Press, 1925.) 2s 6d net.

FEW of those who use scientific instruments realise the important part which Great Britain has played in their development; although not written at all from this point of view, it is easy to see from Dr Gunther's book many examples of the contributions of the British makers and men of science. He points out, for example, that among nautical instruments, the backstaff, which was a great improvement on the fore-staff for the determination of the sun's altitude, was invented by an English captain, John Davis, in 1590, to avoid having to look directly at the sun; then there were the improved quadrants of Edmund Gunter of Oxford, and of Sisson, lastly, the reflecting octants of Newton and Hadley—the immediate predecessors of the modern sextant.

The theodolite, the chief surveying instrument, was the invention of Leonard Digges, of University College, Oxford, and was described by his son in 1571. The accurate dividing of a circle was carried out by Ramsden with his dividing engine in 1763, who thus led the way in the construction of surveying instruments of all kinds.

Of mathematical instruments, Dr. Gunther quotes Stone's remark in his translation of Bion (1758):

"The making of good mathematical instruments is almost peculiar to the English" Napier following his invention of logarithms, devised his "Bones" by which multiplication could be performed mechanically. Shortly after, Gunter (1620) made his "line" and Oughtred his "circle of proportion" (1630), from which the slide rule has descended.

Turning to the telescope, Gregory and Newton devised the reflecting telescopes called after them, and of much greater importance, the refracting telescope was suddenly brought from a clumsy and very defective instrument, a hundred or more feet in length, to an almost perfect instrument through the discovery of achromatism, first by Chester Moor Hall (in 1733), and then by the careful experiments of John Dolland in 1658; the telescopes Dolland made were for their size little inferior to those of the present day.

Lastly, the most important of all scientific instruments, the microscope, from the time of Hooke, who described and illustrated his famous instrument in his "Micrographia" in 1665 (the date 1667 mentioned by Dr. Gunther is the date of the second edition) down to nearly the end of last century, owes all the chief improvements to the British makers. The microscopes of Marshall, Culpepper, Cuff, Adams, Dolland, Nairne, are briefly referred to by Dr. Gunther.

In the Science Museum at South Kensington there is a fairly representative collection of scientific instruments if we include the portion of the fine collection of these old instruments formed by Thomas H. Court during the last thirty years, which has been on loan there so many years; but even including these there are many gaps, especially in the instruments produced during the latter end of the seventeenth and the early years of the eighteenth centuries—a most important period in the development of scientific instruments, as it was during this period that so many of the features that still persist were first introduced.

Oxford has in Dr. Gunther another man of enthusiasm, who seems determined to build up a representative collection there. He has been fortunate in starting with a nucleus of three unique collections—the Orrery collection, made by a grand-nephew of Hon. Robert Boyle c. 1700; the Oriel collection of instruments dated about a hundred years later, mostly constructed by Nairne; and the Lewis Evans collection, recently presented to Oxford.

Dr. Gunther has already published three finely illustrated volumes descriptive of some of the more interesting and important of the instruments, but these are necessarily expensive, while the little book that has now appeared is within the reach of all, and it gives in brief outline a general survey of the collection together with sufficient historic notes to place the instruments

in their true perspective, and to enable the general reader to form some appreciation of the interest and value of the collection.

The University of London has established a degree in the history of science, and it is possible that other universities will follow suit, if so, collections in which students can follow the development step by step will be necessary for any proper appreciation of the subject. As these old instruments—not so much the antiques which are probably safe, but the intermediate links—are being broken up every day by those ignorant of their importance, no time should be lost by other universities, especially the sister University of Cambridge, in forming a similar collection.

Introduction to Biology.

- (1) *Allgemeine Biologie: eine Einführung in die Lehre vom Leben.* Von Prof. Dr. Max Hartmann. Erster Teil: Zelle, Statik, Dynamik und Stoffwechsel. Pp. vi+262. (Jena: Gustav Fischer, 1925.) 12 gold marks.
- (2) *Outlines of General Zoology.* By Prof. H. H. Newman. Pp. xvi+480. (New York: The Macmillan Co., 1924.) 16s. net.
- (3) *A Text-Book of Biology for Students in General, Medical and Technical Courses.* By Prof. W. M. Smallwood. Fifth edition, thoroughly revised. Pp. 393. (London: Baillière, Tindall and Cox, 1925.) 16s. net.

NOT the least evident of the signs that biology is finding its place in a general education is the crop of books intended to introduce the student to it which is now appearing. Three such are before us.

(1) Prof. Max Hartmann publishes the first of two parts of a work founded on his lectures on general biology in the University of Berlin. This is in title and manner an introduction, it is true, but it is an introduction on an ample scale, and suited only to serious students. It is broadly and philosophically conceived, and worked out very systematically in the German way. Prof. Hartmann begins at the beginning. In an opening section he considers the philosophical prolegomena of the subject—the position of biology in the system of the natural sciences, the methodology of the biological sciences, and the scope of general biology.

In treating of methodology, Prof. Hartmann gives an interesting and very judicious exposition of the respective functions of generalising and exact induction, and of the part played by hypothesis and experiment in the development of the science. As might have been expected, he views general biology as primarily the study of cell life, and begins his exposition of its

principles with a survey of our knowledge of the cell. He draws the very necessary distinction between cell and energid, but unfortunately adheres to a use of the former term which compels him to apply it to the whole body of various organisms, from bacteria to *Caulerpa*, which are much better described as non-cellular. It is a pity thus to reduce to absurdity a conception which, rightly used, is of much value. Upon the question of "generative chromidia," which is briefly discussed in this section, the recent observations of Sister Monica Taylor on the life-history of *Amoeba* throw some further light. A survey of the various skeletal and formative structures of cells follows, and then a section upon various types of motion. Here some allusion to recent English and American work on amoeboid movement might perhaps have been made. Muscular contractility and the organs which subserve it are discussed in an excellent summary.

Part I. of the work ends with an admirable survey of the interchange of matter and energy between the organism and its surroundings, illustrated by an elaborate tabular statement. The style throughout is clear, and the illustrations plentiful and well printed. We are promised Part II., which will complete the book, in the course of next year.

(2) and (3) The other two books are ordinary enough examples of a common type—the introductory textbook for elementary students. Prof. Smallwood writes for students of biology, Prof. Newman for those who are studying zoology. Each states briefly a number of elementary facts and theories. Each at least avoids giving the impression that biology consists in a knowledge of the comparative anatomy of a series of organisms and some speculations as to the course of their evolution, but neither, we think, has avoided the opposite danger of superficiality. Prof. Newman's is the better book.

Our Bookshelf.

The Foundations of Colloid Chemistry: a Selection of Early Papers bearing on the Subject. Edited, on behalf of the Colloids Committee of the British Association, by Emil Hatschek. Pp. 173. (London: Ernest Benn, Ltd., 1925.) 18s. net.

MR. EMIL HATSCHKE has rendered a real service to all students of colloid chemistry by collecting early fundamental papers on the subject, six by foreign investigators being translated into English. The book makes no pretence to develop a historical account of the growth of colloid chemistry, but rather indicates certain outstanding conclusions which subsequent research has substantiated.

The first paper is by Ascherson (1840), who dealt with protein absorption at the interface: oil-aqueous solution. His results have been almost entirely overlooked by the many investigators who have since

published work on similar lines. With remarkable insight he speaks of "capillary condensation" at the interface between heterogeneous liquids, the modern notion of adsorption.

Three papers by Selmi (1845, 1847, 1850) disclose experiments and deductions little known to the majority of students. He recognised many colloidal solutions, naming them "pseudo-solutions," and anticipated the importance of the organic colloids. The pseudo-solutions could be coagulated by electrolytes, a fairly wide selection being tried out. The paper by Selmi and Sobrero, dealing with sulphur sols, is very important historically. A paper by Graham, "On the Properties of Silicic Acid and other Analogous Colloidal Substances," introduces nomenclature now firmly established.

The colloidal chemistry of metals has attracted numerous workers, and the subject lends itself admirably to quantitative treatment. It is satisfactory, therefore, to find the classic papers of Faraday (on gold sols), Muthmann (on silver sols), and Carey Lea (on silver sols). Faraday believed that his ruby sols contained solid gold in extremely fine division, and he mentions the use of a light cone to show up the particles; the Tyndall cone should really be termed the Faraday-Tyndall cone. Muthmann (1887) published his experiments on the dialysis of metal sols, an outstanding achievement in colloid chemistry. Carey Lea's work is somewhat better known, a complete edition of his papers having been translated and edited by Lüppe-Cramer. The remarkable publication of van Bemmelen (1888), "On the Nature of Colloids and their Water Content," is essential to the study of gels, and pointed to a new field in colloid chemistry.

Mr. Hatschek has provided most useful notes to all these papers, and he is to be congratulated on his work as editor and translator. The publishers have also done their work well.

WILLIAM CLAYTON.

Introductory Geology: for Use in Universities, Colleges, Schools of Science, etc., and for the General Reader.

Part 1: Physical Geology, by Prof. Louis V. Pirsson;
Part 2: Outlines of Historical Geology, by Prof. Charles Schuchert. Pp. x+693. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 20s. net.

THE text of Part 1, "Physical Geology," first appeared in 1915 in Pirsson and Schuchert's "Text-Book of Geology," a revised second edition of which was published in 1920. With the exception of the chapter on ore deposits, which has been rewritten by Prof. A. M. Bateman, Part 1 in the present volume is reprinted from the second edition of the "Text-Book." The subject is treated under two main heads, dynamical geology and structural geology. In the first section the various geological agents and their work are dealt with fully but concisely, the geological work of organic life not being neglected. The second section is a well-arranged and comprehensive account of the composition, character, relations, and structures of the rocks forming the earth's crust. In scope and treatment the whole is an excellent introduction to the subject for students, and it must also be of interest to the general reader. The illustrations are good and include both reproductions of photographs and diagrams. There is an appendix on important minerals.

Part 2, "Outlines of Historical Geology," is a greatly reduced version of the author's "Historical Geology" in the "Text-Book of Geology" of Pirsson and Schuchert. In thus cutting down the original manuscript, the author has succeeded in producing a book more suitable as an introduction to the subject. The contents are well arranged, the first chapters dealing briefly with the changing aspect of the earth's surface, evolution, fossils, and the geological record, and thus prepare the way for an account of the history of the earth during the successive geological periods. This account is related with special reference to North America, and these chapters are therefore mainly a geological history of that country. Other chapters are devoted to the coming of land life, the evolution of mammals, and man. There are abundant illustrations of fossils and restorations together with numerous palæogeographical maps. A folding geological map of North America is appended. The volume includes a very full index.

The Natural History of Wicken Fen. Edited by Prof. J. Stanley Gardiner. Part 2. Pp. 65-171. (Cambridge: Bowes and Bowes, 1925.) 6s. net.

THE second part of this valuable work on the natural history of Wicken Fen includes an account of the dragon flies, the bugs, the Ichneumonidae and some of the other less popular families of insects, the spiders, the wood lice, the leeches and the mollusca. It also contains an account of some observations on the hydrogen ion concentration of the waters of the Fen, and on its Phytoplankton, and an interesting essay by Dr. A. H. Evans on the history of Wicken and Burwell Fens.

We may congratulate the editor on the style in which his contributors have written their parts, for they write not only with authority on their several subjects, but also in a manner that interests the naturalist who has no special knowledge of the groups that are described. In the literature of the British fauna there are found many records which are simply unintelligible to any but the highly specialised systematists. There are no suggestions to excite the interest of the more general reader on the habits, associations, rarity, and other points of interest of the animals included in the long lists of specific names. There is no article in this volume to which this criticism could be fairly applied, for in every one of them we seem to catch the spirit of the true naturalist instead of that of the mere collector. With this little volume in his hand a visitor would have at least some idea as to what to look for and how to find it.

Mr. Saunderson's essay on the hydrogen ion concentration of the water is a novelty in works of this description, but we hope it will be followed by others of a similar kind. It has often been a puzzle to naturalists why some ponds are so rich in their microfauna and others so poor. Is the solution of this puzzle to be found in the pH?

Reference cannot be made in detail to the individual essays in this part of the series, but as a whole it affords additional commendation for the wisdom and public spirit of those whose efforts have led to the preservation of Wicken Fen from the destructive forces of modern civilisation. The series should be in the library of every naturalist.

Scientific Paradoxes and Problems and their Solutions ; Simultaneously Broadcast from 2LO. By A. S. E. Ackermann. Pp. viii + 131. (London: The Old Westminster Press, 1925.) 5s. net.

MR. ACKERMANN is the author of a successful book on popular fallacies, now in its third edition. Early in 1925 he was engaged by the British Broadcasting Company to give a series of talks on popular fallacies connected with engineering and science. Listeners were invited to send such paradoxes to the speaker, and the pick of the matter received by him has been collected into the volume now noticed. Some of the problems, which seem trivial to a mind versed in science, are yet a source of constant perplexity to the general public.

A great number of people are attracted by arithmetical, geometrical, and mechanical puzzles, and the author found that a surprising variety of posers, many being of a very high quality, were sent to him by interested listeners. The solutions of some of the problems included will be obvious to many schoolboys. A few of them are mere verbal conundrums. From the more elusive questions discussed we select two, which are sufficient to indicate the scope of Mr. Ackermann's book. 1. (p. 70). Given two straight bars of steel identical in every respect with the exception that one of them is magnetised, in what way can it be determined which bar is magnetised? No third article of *any kind* is to be used. You may not even balance one or both bars on a finger or finger-nail, but you may hold the bars in your hands. 2. (p. 75). In going up a wide, steep road on a bicycle or other vehicle, does it make it any easier for the bicycle rider, horse, or engine of a car if a zigzag course be taken?

The solutions throughout are given in non-technical language and should appeal to any intelligent person without specialised training in science. We foresee a wide circulation for Mr. Ackermann's book: few readers will go through its pages without finding much to instruct them—and all of it presented in an entertaining way. W. E. H. B.

Electrical Engineering. By Prof. L. A. Hazeltine. (Engineering Science Series.) Pp. xvi + 625. (New York: The Macmillan Co., 1924) 30s. net.

THE author of this volume is the professor of electrical engineering in the Stevens Institute of Technology. It is primarily intended for the students in his classes, but it will be of interest to many teachers of physics and engineering in Great Britain. The author writes clearly, his object being to explain the essential elements of electrical science and its applications. It will prove useful as a class-book, and we also think that it will be useful to the private student who has a sound knowledge of elementary physics. The rational system of units is employed, the permittivity of a vacuum being taken as $1/(4\pi)$. Some formulæ are simplified, but others are made slightly more complex. The "true" units and the "international" electric units are both given. Seeing that now testing laboratories can measure resistances, and so on, in true units with an accuracy far exceeding that required in industry, we think that the time has come when the "international" units can be regarded as obsolete. No instrument reads absolutely correctly, and the "tolerance" permissible, with a given type of instrument, is many

times greater than the possible error in calibrating the standard in true units. Mathematical proofs are always given when they can be understood by the average student, but advanced mathematical proofs are excluded. Many collections of problems are given throughout the book, and we were glad to see that the answers are given to them.

Practical Radio: including the Testing of Radio Receiving Sets. By James A. Moyer and John F. Wostrel. Pp. vii + 249. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd, 1924.) 8s. 9d. net.

RADIO broadcasting has greatly interested the public in radio science. There are many amateurs who have an excellent working knowledge of the art but lack that specialised knowledge of the science which alone can give them the confidence necessary for success. This book is clearly written and can be recommended to any one who wants to know standard modern practice and desires a simple introduction to elementary theory. A chapter is devoted to the future of radio, but the author rather confines himself to the history of past triumphs. A good description is given of the apparatus used for transmitting photographs over long telephone wires on a commercial scale; vacuum tube amplifiers, photo-electric cells and synchronising arrangements form an essential part of the method. It is therefore an adaptation of devices developed in connexion with radio communication, telegraphy and telephony. Future improvements in radio reception will probably consist of replacing storage batteries and dry cells by devices which can be connected with the electric supply; for example, a suitable thermocouple. As amplifiers become more sensitive a large antenna becomes unnecessary. Many sets operate with a loop at present, but in the future this loop will probably be very small. The elimination of static disturbances by directive reception is also mentioned.

Faune de France. 9: Amphipodes. Par Ed. Chevreux et Louis Fage. (Fédération Française des Sociétés de Sciences Naturelles: Office Central de Faunistique.) Pp 488. (Paris: Paul Lechevalier, 1925) 60 francs.

THE volume opens with a short statement of the characters of the order Amphipoda and of its three suborders, followed by an account of the habitats in which Amphipoda occur, the methods by which specimens may be obtained, studied, and preserved, and by a useful description of the external morphology and internal structure. Tabular keys are provided to the families, genera, and species—some 320 of the latter being considered. Under each species is given a concise statement of its characters—illustrated by clear line drawings, for the most part original—and of the distribution of the species in France, with a note of the neighbouring countries from which it has been recorded. Appended is a list of works on Amphipoda and there is an adequate index.

The present volume, like its predecessors in the same series, will receive a warm welcome in Great Britain, and will be of great service to those interested in the order of which it treats.

ERRATUM.—Page 461 of issue of September 26, col. 1, line 26, for "Microscopic Reactions" read "Macroscopic Reactions."

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Carnot's Cycle and Efficiency of Heat Engines.

ON p 326 of NATURE for August 29 appears an abstract of a paper by Dr J S Haldane, which he read before the Institution of Mining Engineers on June 16. In this paper he has "thrown to the winds" the usual academic teaching in regard to the efficiency of a Carnot cycle, and has put forward a claim that another cycle has a greater efficiency. This, which for brevity we will call the Haldane cycle, consists of an adiabatic expansion BC (Fig 1) followed by an isothermal compression CA and a constant volume heating AB. In the discussion on the paper, I proved that this cycle has only about half the efficiency of a Carnot cycle working between the same limits of temperature. This proof did not make use of Carnot's principle, but required only a knowledge of the thermal properties of air, which was treated as a perfect gas. In such a case it is perfectly easy to calculate the work done and the heat changes and therefore the efficiency.

Dr Haldane has challenged these conclusions, their truth, however, can be seen in other ways.

In the Haldane cycle heat (say H_1) is taken in along AB and heat H_2 is given out in the condensation along CA (see Fig 1). The balance of work done is the difference between the work of expansion along BC and the work of compression along CA, this balance is represented by the area ABC.

Now to increase the efficiency we require to increase the work for a given quantity of heat rejected along CA. This can be done by replacing AB by an adiabatic compression AD which raises the temperature to that at B followed by an isothermal expansion DB. By making this change we have obviously practically doubled the area representing the balance of work available without altering the amount of heat H_2 rejected. But the new cycle so obtained is a Carnot cycle; this has therefore a greater efficiency than a Haldane cycle. When the difference of temperature is small the double area implies double efficiency, because H_1 and H_2 are nearly equal. But detailed calculation shows that it is practically so for differences as large as 200 degrees.

Of course more heat is now taken from the boiler (along DB), because the principle of conservation of energy must be satisfied—unless this principle is another which may be "thrown to the winds".

These conclusions can be verified by detailed calculation for the case where the working substance is a perfect gas. Air at moderate pressure is so nearly a perfect gas that they cannot be far wrong for air. What Carnot did was to give reasons for declaring that the efficiency for a given range of temperatures must be independent of the substance used in the cylinder in the case of reversible cycles. Whatever the efficiency may be for a perfect gas must be precisely the value for air also or for steam or even for ice. His reasoning was imperfect because it was based upon the caloric theory of heat. But it

had such a form that when the energy nature of heat came to be recognised, the reasoning was easily transformed by Clausius (1850) and Kelvin (1851) so as to suit the general law of conservation of energy. The reasoning was transformed although the conclusion remained the same and is still known under Carnot's name.

The proof of the law of efficiency does not rest on the performance of actual steam-engines. These are always less perfect because they are not reversible. To those who cannot rise to the necessary heights of abstract reasoning the Carnot-Clausius-Kelvin proofs can be replaced by the more tangible facts that the thermal properties of any substance are connected together by relations which require the exact truth of the Carnot law. For example, the latent heat of a substance can be calculated from observations of pressures, volumes, and temperatures. The latent heats of substances would not be what they are if the law were untrue. It will take more than the unsupported assertions of Dr. Haldane to disturb convictions based upon the immense amount of evidence in the realm of physics which requires the truth of Carnot's theorems.

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Mutant Groups in Nature.

WHILE staying at Val d'Isère (Savoie) this summer, I noticed some facts which seem worthy of record as bearing on the evolutionary importance of mutations. *Gentiana campestris* L. was an abundant plant in many localities round the village. Not infrequently variants were noted in which the corolla was white and the leaves paler green than normal ("albinos"). It is not to be doubted that such forms have arisen from the type by a recessive mutation. Sometimes these mutants were found singly. This is in my experience the usual state of affairs with white-flowered mutants of other wild species (e.g. wild hyacinth), and was also the case with pink-tinged *Saxifraga oppositifolia* noted by me in Spitsbergen in 1921.

The fact which struck me as interesting, however, was the discovery, on five occasions, in quite separate localities, of groups of albinos. In two cases the groups were small, comprising only a score or so of individuals. In two further cases the number of individuals in the group was several hundreds, and in the last and most remarkable group it was certainly well over a thousand, and very possibly several thousands. This largest group was found on the left bank of the Charvet torrent, almost exactly at the waterfall which forms a conspicuous object in the view from Val d'Isère, about 2 miles up the Calabourdane valley. It would be interesting if botanists who were in this area would visit it from time to time to see whether it maintained itself. Over an area of ground about 70 paces long and 15 to 20 paces broad, albinos were very abundant, only one or two scattered type plants (purple-flowered) were discovered, after some searching. Round this patch was a zone apparently unsuited to the growth of this plant, extending away from the stream for 40 or 50 yards, upstream for nearly as much, and downstream for almost 100 yards, the stream itself formed a barrier on the fourth side.

The other two large groups, one of which was about 10 x 15 yards in extent, also showed a very few normal plants. In one at least of the small groups, no normals were found within this albino group. The isolation of the group by a zone unsuited to the species was clear also in one of the moderate groups, but definitely did not exist in one of the small ones. I have no notes on the point for the remaining two groups.

These groups, all belonging to a distinct and obviously mutant type, strongly recall the findings of R. E. Lloyd in rats in India ("The Growth of Groups in the Animal Kingdom," London, 1912). Here, however, the fate of the group might be followed year by year, which was difficult or impossible for the rats.

The most probable explanation of the existence of such groups is that they are all descended from a few or probably a single mutant ancestor. The ecological isolation of the areas occupied by some of the groups is interesting. When such isolated areas occur, then, should especially adverse circumstances kill off a species over part of its range, if a mutant chance to be the first to recolonise an isolated patch, it has a good chance of populating the whole patch; whereas (if recessive and non-advantageous) if not isolated it will tend to be swamped. Once the patch is colonised with the mutant, it will not be easily invaded by the type unless the mutant is markedly less hardy. For a detailed discussion of these points, see C. S. Elton, 1924 ("Periodic Fluctuations in the Number of Animals," etc., *Brit Jour Exp Biol*, 2, p. 119), and A. L. and A. C. Hagedoorn, 1921 ("The Relative Value of the Processes causing Evolution": The Hague). It is to be noted that the patches tenanted by the white plants were not newly exposed ground, but similar in every way, so far as could be seen, to the neighbouring areas where the type plant was abundant.

It is in any case interesting to find a mutation which by analogy is almost certainly recessive, and most probably less vigorous than the type, capable of colonising and holding in force areas as large as that described. It shows how easily mutations may become established in nature. If the mutation were of smaller extent and less unfavourable it would have still more chance of surviving, though less of detection; if it possessed a biological advantage over the type, *a fortiori* it would survive still more readily. In any case, the importance of tiny semi-isolated areas within the habitat of a species may be expected to provide, as in this case, occasional "reservoirs" of mutants. Such "reservoirs" would also be expected in normally self-fertilised species, though the isolation here would be physiological.

I have no doubt that similar cases must be known to botanists, and that many more are awaiting discovery. Meanwhile, I venture to record these observations for what they are worth.

JULIAN S. HUXLEY.

Department of Zoology,
King's College, London, W.C.2,
September 12

Coastal Refraction of Wireless Waves.

DR SMITH ROSE, in his letter on this subject in NATURE of September 19, has directed attention to the striking discrepancy between theory and experience in the matter of coastal refraction of wireless waves. It may be of interest to point out that the conclusion, to which he is led from Zenneck's analysis, that waves travel with a greater effective velocity the lower the conductivity of the surface, though contrary, I believe, to what is now generally accepted, is supported by quite simple reasoning.

If we make Zenneck's assumption that at a considerable distance from the transmitter we have to deal with a single wave, sensibly plane, it follows that (neglecting the conductivity of the air and assuming its S.I.C. is unity) the wave must be travelling with the speed of light.

Further, since there is only one wave, the conditions at the surface must be those for an incident and refracted ray but without reflected ray,¹ that is, the wave must be incident at the critical, or Brewsterian, angle of incidence (i) given by

$$i = \tan^{-1} \mu \quad (1)$$

where $\mu = \sqrt{K - \frac{2j\sigma}{n}}$ is the refractive index of the ground and

K is the S.I.C. of the ground,
 σ is the conductivity (E.S.U.) of the ground,
 n is the frequency of the waves.

The forward tilt of the waves ($90^\circ - i$) implied by equation (1) is identical with that obtained by Zenneck.

The velocity (V) of such a wave along the surface can only be defined as the product of frequency into wave-length (i.e. distance apart of two crests) measured along the surface, so that we see from Fig 1

$$V = n \frac{\lambda}{\sin i} = c / \sin i = c \sqrt{\frac{\mu^2 + 1}{\mu^2}} \quad (2)$$

(where c = velocity of light), and this is identical with the expression for superficial velocity obtained by

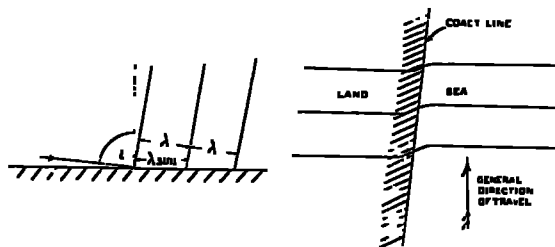


FIG 1.

FIG 2.

Zenneck and referred to by Dr. Smith Rose. Now μ decreases with decreasing conductivity, so the velocity will increase and be greater over land than sea.

If V_1 is the velocity over sea,
 V_2 " " " " land

The ratio V_1/V_2 , which may be called the coastal refractive index (μ_c), is obtained by

$$\mu_c = V_1/V_2 = \frac{\sin i_2}{\sin i_1} = \sqrt{\frac{\mu_2^2(\mu_1^2 + 1)}{\mu_1^2(\mu_2^2 + 1)}} \quad (3)$$

(where μ_1, μ_2 are the refractive indices for land and sea). But, in the case of sea, $\mu_1^2 \gg 1$ for commercial frequencies, so that

$$\mu_c = \sqrt{\frac{\mu_2^2}{\mu_2^2 + 1}} \quad (4)$$

The coastal refractive index is thus less than one.

In the face of the experimental evidence,² which seems to me very decisive, we are left with the conclusion that coastal refraction must be the result of other causes than a difference in superficial velocity.

I think that there is a possible explanation in the fact that there is greater absorption of the waves on land than on sea. The part of the wave-front on land must, for this reason, be weaker than that on sea, with the result that a continual transference of energy must take place across the boundary at right angles to the general direction of travel of the waves. This will give rise to a kink in the wave-front in the

¹ I now find Bouthillon has used much the same argument in a criticism of Zenneck's work (see *Onde Electrique*, May 1923), but not in connexion with this particular problem.

neighbourhood of the boundary in some sort of manner as shown in Fig. 2.

This would account qualitatively for the facts. A mathematical development on these lines would be necessary in order to show whether it also gave quantitative agreement

R. H. BARFIELD,
Radio Research Board Station,
Slough.

Spermatogenesis of Spiders.

I HAVE been much interested in Prof. Ernest Warren's letter in NATURE of September 12 on the spermatogenesis of spiders, in which he claims amitotic division of spermatogonia, an abnormal type of maturation, and finally the formation of many spermatozoa from chromatin bodies, bereft of cytoplasm.

I recognise that it is naturally difficult for any one, in the limited space afforded by a letter to NATURE, to give an adequate account of the phenomena described by Prof. Warren; nevertheless, I feel that there is need for caution in accepting his results. The spermatogonial nucleus is polymorphic and lobulated, in itself no evidence of amitosis: the great Meves himself mistook the polymorphism of amphibian germ cells for amitosis—a mistake finally cleared up by Champy.

The formation of more than four spermatids from one spermatocyte is known in moths, where this effect is brought about by an extra, but normal, mitotic division.

Prof. Warren's figures 9-12 seem to recall apyrene sperm formation, or the degenerative changes found in many effete insect germ cells.

I feel that while Prof. Warren has described what may be an interesting cytologic phenomenon, he has not convinced your readers that fertilisation in his spider is not brought about by a normally formed sperm.

Nevertheless, I would be glad to see some of Prof. Ernest Warren's material upon which his results are based

J. BRONTÉ GATENBY.

Trinity College, Dublin,
September 14.

PROF. WARREN'S most interesting letter in NATURE of September 12 on the subject of spiders concludes with the challenging remark that "It would be obviously absurd to suppose that the mechanism of heredity differs fundamentally in certain spiders from that in other organisms." Why absurd? Spiders belong to a line of evolution remote from the mammals, for example, and a line which obviously "stuck"; and may this not be because its mechanism of heredity was not entirely satisfactory? Other lines carried on to the higher groups, and may it not be just because mammals possess a somewhat different and more useful mechanism for their heredity?

MARIE C. STOPES

Givons Grove, Leatherhead,
Surrey.

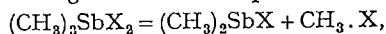
Antimonial Analogues of the Cacodyl Series.

IN view of the interest now manifested in organic derivatives of antimony, we desire to place on record our discovery of the antimonial analogues of the cacodyl series on which we have been engaged during the last three years.

Although aromatic antimonials are known containing the metal combined with one or two aryl groups,

so far the only well-authenticated aliphatic antimonials belong exclusively to the tertiary stibine series in which antimony is associated with three alkyl radicals as in trimethylstibine, $(\text{CH}_3)_3\text{Sb}$.

The following thermal decomposition,

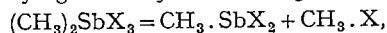


has been generalised for the dihalides of trimethylstibine and leads to dimethylstibine chloride, bromide and iodide corresponding with cacodyl chloride, bromide and iodide in the arsenical series.

Dimethylstibine oxide has also been obtained, and the antimonial series has been completed in this laboratory by Mr. V. E. Yarsley's collaboration in the preparation of dimethylstibine cyanide, the analogue of Bunsen's cacodyl cyanide.

Antimony cacodyl itself has not been isolated in a state of purity, although its existence among the reduction products of dimethylstibine bromide has been demonstrated.

By carrying demethylation a stage further,



we have obtained another new series of alkyl antimonials in which the metal is associated with only one methyl radical.

The following historical coincidence may also be of interest. Cacodyl and cacodyl oxide were originally prepared by L. C. Cadet de Gassicourt in 1760 when engaged on service work for the French army of that day, whereas the investigations referred to in this note have arisen out of war work for the British Military Authorities.

G. T. MORGAN.

G. R. DAVIES.

University of Birmingham, Edgbaston,
September 15.

Thunderstorms and the Sound of Lightning.

I WAS interested in reading the recent correspondence in NATURE about the sound of lightning, for I also have once heard it. It was in East Griqualand one evening when, in the midst of a storm, I saw a blinding flash, followed almost instantaneously by an explosion like a shell. But between the flash and the crash there was a distinct small pistol-shot-like sound, immediately after the flash.

The Transvaal is a noted place for thunderstorms. On Christmas Day 1923 I witnessed what I should imagine must almost be a world record in the way of storms. It occurred in the late afternoon and evening over the Pretoria district. From my balcony I had a fine view of it about twenty miles away on the horizon. There were really two storms, one about 6 and the other between 7 and 8.30. I saw the latter. The flashes for about twenty or thirty minutes during the time I looked on must have been at the average rate of well over one per second. Mr. Stewart, the Government meteorologist at Pretoria, kindly gave me some statistics of the storm. He said that in three minutes there were the astonishing number of 360 flashes, an average of two per second. I should imagine that for something like an hour perhaps there were an average of 100 flashes per minute. It was a wonderful sight: the sky in the north towards Pretoria was simply one blaze of light. The damage done by the hail was tremendous, and one woman died from shock. It would be interesting to hear if any of the widely spread readers of NATURE in other parts of the world have ever seen a worse thunderstorm.

T. B. BLATHWAYT.

Box 7532, Johannesburg,
August 19.

The Mineral Elements in Animal Nutrition.¹

By Dr. J. B. ORR.

SINCE the time of Lavoisier, research in nutrition has been directed chiefly to the chemistry and metabolism of organic compounds, *i.e.* proteins, fats, carbohydrates and allied substances, and in tables of rations the food requirements of animals have been expressed in terms of these or their equivalents. During the past half-century, however, an increasing number of workers have become interested in the rôle played by inorganic salts in nutrition. The information being yielded by the researches of these workers is throwing new light on many fundamental problems of biology, and some of it appears to be of potential economic value in animal husbandry.

From 10 to 25 per cent. of living matter consists of organic compounds of which the colloidal material of the protoplasm is formed. The remaining 75 to 90 per cent. consists of water and inorganic salts. In the recent literature of animal husbandry, the elements of these salts have been somewhat loosely termed "the mineral elements," to distinguish them from the carbon, hydrogen, oxygen and nitrogen of the organic compounds. In living matter these mineral elements are present, partly in chemical combination with, and forming an integral part of, organic compounds, and partly free or potentially free, either in solution as salts or ions in the water of the protoplasm, or in a temporary loose union with the colloids.

The fundamental nature of the functions of the so-called mineral or inorganic salts in life processes is at once apparent when we consider the part played by them in the origin of the cycle of energy exchanges which occur in the "organic world." All forms of life depend ultimately upon the transformation of the energy of sunlight into chemical energy. The power of carrying out this fundamental process, which can be regarded as the real origin of life, is possessed by inorganic salts in colloidal solution. Photosynthesis with the production of formaldehyde, which contains the trapped energy of the sunlight, arises from the action of sunlight and inorganic salts on water and carbon dioxide. According to Moore, chlorophyll itself is a product of photosynthesis, and its chief function is probably not the primary one of deoxidising the carbon dioxide and thus charging the carbon with energy, but of changing the formaldehyde into higher carbon compounds. Hence the beginning of life-processes lies in the action of radiant energy on inorganic salts. The carbon atom is harnessed as the most suitable vehicle for conveying the chemical energy formed. The giant molecules and colloidal aggregates with their complex carbon-containing compounds, which have been regarded as the fundamental organic substances, are really secondary developments to secure that degree of stability and complexity required for the evolution of higher forms of life. Thus the true basis of protoplasm is the saline solution which forms from 75 to 90 per cent. of its bulk and still resembles the sea water from which it originated.

It is impossible here to do more than refer briefly to the nature of the functions of the inorganic salts

and ions. As has been already indicated, these functions are intimately connected with colloidal activities. The visible phenomena of life are the resultants of an enormous number of chemical and physical changes in the colloids of protoplasm and of exchanges between masses of protoplasm separated by membranes or interfaces. But these changes in the physical state of colloids are determined by the association and dissociation of colloids and inorganic ions. These ions also affect the permeability of membranes and the tensions at interfaces. Hence, in a real sense, protoplasmic activity is regulated by the action of the mineral elements in solution in the protoplasm or attached to its colloids. Thus, in the contraction of muscle, though the ultimate source of energy is the oxidation of organic compounds, the initiation of the process, the mechanism by which it is carried through and the factors by which it is controlled, depend on the action of the ions and salts present, which involve changes in osmotic pressure and other physical forces.

The foregoing considerations suggest that definite degrees of concentration of the various inorganic ions in the cell fluids are necessary for the maintenance of normal protoplasmic activity. This has been fully demonstrated by work done to determine the effect of changes in the normal concentration of the different ions. The results of experiments with unicellular organisms and with isolated organs such as the perfused heart have shown that slight alterations either in the absolute or relative concentrations of any of the inorganic ions may accelerate, retard, or even reverse processes being carried out by means of the colloidal mechanism.

In the animal body these changes in the concentration of the inorganic ions can be correlated with changes in the functions of the organs. Thus, all the organs regulated by the central nervous system depend for the integrity of their functions upon the maintenance of definite ratios of calcium, potassium, and sodium in the fluids within the nerve tissues. Changes in the relative proportions of these are accompanied by alteration in the excitability of nerve and in the irritability of muscle. The classical experiments of Ringer on the perfused heart show that minute changes in the concentrations of calcium or potassium in the perfusing fluids have a profound effect on the activity of the heart. These examples are merely illustrations of the general law that any disturbance of the normal physiological balance of the salt solution of the body is accompanied by a correlated impairment of function.

The body is remarkably efficient in maintaining this balance, in spite of the fact that there is a continuous loss in the excreta, and the mineral matter of the food is liable to be very different in composition from that found in the blood. Within limits, the elements present in excess tend to be excreted and those deficient to be conserved. The bones act as a reservoir, especially for calcium and phosphorus, the two required in largest amounts. Reserves can be deposited in the bones when the supply is ample, and mobilised in

¹ From the presidential address delivered at Southampton on August 31 before Section M (Agriculture) of the British Association.

times of need. It is probable that this function of the bones, namely, regulating the supply of mineral elements to the body fluids, is as important as the more obvious one of providing a rigid framework. It is probably more fundamental, for, when the available mineral matter is insufficient to maintain both the physiological balance in the blood and the rigidity of the skeleton, it is rigidity which is sacrificed. There is little doubt that in most diseases affecting the bones the skeletal symptoms are only secondary manifestations of the influence of some factor, often a dietary one, which upsets the balance of mineral elements in the blood.

Under experimental conditions it is possible by feeding diets with marked deficiencies or excesses of some of the mineral elements to produce conditions of malnutrition which are so definite and marked that they are as easily recognised as definite diseases; indeed similar conditions occurring in practice are regarded as definite diseases. Thus, primary anaemia, simple goitre and rickets are produced by deficiency of iron, iodine and either calcium or phosphorus respectively. An interesting case of a disease due to an excess of a mineral element is reported by McCollum, who regards an inflammatory condition of the eyes, resembling xerophthalmia, which he calls "salt ophthalmia," as due to excess of chlorine in the food.

In addition to these diseases due to excesses or deficiencies of mineral elements in the diet, in which the symptoms form a definite and easily recognised picture, and the cause is admitted, there are conditions of malnutrition due to the lack of balance of the mineral elements in the diet, where the signs are much less obvious. In young animals there may be retarded growth without any definite pathological symptoms. The only reason for supposing that such animals are not in a perfect state of health is that their rate of growth is not optimal, as is shown by the fact that improvement follows the adjustment of the mineral balance in the food. Thus, Kellner obtained an increased rate of growth in calves by the addition of a calcium salt to a diet on which the animals grew at an average rate and showed no signs of obvious ill-health. In some work, not yet reported, we have found that the addition of traces of iodine to the diet of stall-fed calves in winter increased the rate of growth as compared with that of control animals whose condition would be regarded as normal. Further, it has been shown recently that the supply of minerals in the food of the mother may have a profound influence on the vitality of the young at birth and for some time after, even where there may be no obvious effect on the mother. Thus Hart, Steenbock and Humphrey have noted that deficiency of calcium in the diet of cows may lead to the birth of dead or weakly calves, and Ennis Smith has shown that deficiency of iodine in the food of pigs may lead to the birth of dead young, although there is not, in either case, any obvious pathological condition apparent in the mothers.

Some attention has recently been devoted to the question of an increased susceptibility to certain infectious diseases in cases of malnutrition due to deficiencies of minerals. We have noted in feeding experiments that the mortality from intercurrent infec-

tions is much higher in the groups fed on diets which, for experimental reasons, are ill-balanced or deficient in mineral matter. Meigs has noted a similar increased incidence of diseases in cows on diets deficient in calcium.

It may be of interest to consider some reasons which can be adduced for believing that the danger of deficiencies of minerals in the food of farm animals has been increasing in recent years. During the past half-century, the types of animals after which breeders have been striving are those whose young have a very rapid rate of growth, or whose females have a great capacity for producing the constructive materials required for growth. A remarkable degree of success has attended these efforts of the breeders. Some breeds of pigs will increase in weight from 2 lb. to 2 cwt. in six months. There are dairy cows which can secrete in their milk as much as 10-12 lb. of solid matter per day. There are hens that lay 200 to 300 eggs in a year. Now, the faster the rate of growth, the greater must be both the absolute amount of mineral matter required in a given time and the proportion of mineral matter per unit of energy in the food. The following table shows that the percentage of mineral matter in the milk of different species, and also the amounts relative to the energy values, are in proportion to the rates of growth.

TABLE I.

	Number of Days in which Weight of New-born Animal is doubled	Milk of Species contains	
		Ash per cent.	Ash per 1000 Calories.
Man . .	Days. 280	0.25	Grams. 3.7
Cow . .	47	0.72	10.5
Pig . .	14	1.03	10.9
Rabbit .	6	2.50	15

Hence, in modern types of animals the mineral requirements have increased *pari passu* with increased capacity for growth, and the danger of malnutrition through an absolute deficiency of any of the mineral elements, or a lack of balance of these constituents of the food, is correspondingly increased. As a matter of fact, it is found that malnutrition due to disordered mineral metabolism occurs most readily in those animals that are growing fastest. In experiments with both dogs and pigs it has been found that symptoms of rickets tend to appear earliest in those that are growing most rapidly.

Concurrently with the evolution of these faster growing types, with their greater need for each of the essential mineral elements in their food, and for a more perfect balance of these elements, there has been an increasing use of concentrates to support rapid growth. These concentrates, which consist chiefly of commercial by-products of cereal grains and tropical seeds and nuts, are markedly deficient in some of those mineral elements which are required for growth, or for the production of growth material. The following table compares the mineral matter of some of these artificial feeding stuffs with that of milk and good mixed pasture, the only two foodstuffs of which the

mineral content corresponds approximately with the requirements of herbivora.

TABLE II.

	1000 Caloric Portions contain					
	Protein	Calcium	Phosphorus	Sodium	Potassium	Chlorine
	Gm	Gm	Gm	Gm	Gm	Gm.
Cultivated pasture .	65.3	2.65	1.18	0.69	9.58	3.52
Cow's milk	51.6	1.73	1.52	0.58	2.66	1.39
Potatoes	27.4	0.19	0.65	0.29	4.61	0.32
Maize	28.6	0.02	0.76	0.08	1.13	0.0003
Wheat	35.0	0.13	1.18	0.11	1.32	0.15

It is seen from the table that foodstuffs such as tubers and cereals are deficient especially in calcium, chlorine and sodium. Most concentrates resemble cereals in their mineral composition.

A third factor with an adverse effect on mineral metabolism is the increasing tendency to feed large numbers of animals together. This necessitates for practical purposes the adoption of fixed standard rations, which may be fed with little or no change for months on end, or even through the whole life-cycle of the animal. Unless such rations are almost perfectly constituted with regard to their mineral content, there must be a cumulative effect of any deficiency or lack of balance which would not occur in the case of either single animals or small groups, fed in a more haphazard fashion. As a matter of fact, in practice, the cottager's pig, with a varying diet consisting largely of scraps, differing in kind from day to day, seems less liable to disease and more successful in bearing and rearing large litters than pigs fed in large numbers under what might almost be termed factory conditions.

The reasons adduced above seem valid enough to justify the fear that, under modern conditions of intensive production in animal husbandry, there is a danger of malnutrition and disease arising on account of defects in the inorganic portion of the ration. Acting on this belief, attempts have recently been made to increase the rate of growth and improve the condition of animals by the addition of various mineral salts thought to be present in their rations in insufficient amounts. In many cases marked beneficial effects have been noted. Thus in pig-feeding, the cereal grains and most other foodstuffs commonly used in making up rations are deficient in calcium, sodium, chlorine and, in some cases, iron and iodine, and it has been found that growth, health and reproductive capacity all tend to be improved by the addition to the food of salt mixtures or foodstuffs such as fish meal or meat meal which are rich in these elements.

In poultry it has been found, in experiments carried out at Ohio and at stations in Scotland and Northern Ireland, that even though the birds have access to green food and lime or oyster-shell, egg-production can be increased by the addition to the cereal rations usually fed to poultry of a mixture of those salts which are present in the ration in smaller proportions than in egg.

Of all farm animals, the stall-fed heavy-milking cow

is the one most likely to suffer from depletion of minerals from the tissues and consequent malnutrition, on account of the fact that it loses from its body such relatively large quantities of mineral matter in the milk. In short tests, running for a few days or weeks, the adjustment of the mineral matter of the ration is not usually followed by increased milk production, because the cow will continue to give milk even though the body is being depleted of minerals. But the influence of adjusting the ration is seen towards the end of a long lactation or in a subsequent lactation. In recent tests at Beltsville and Ohio and at Aberdeen, which have been carried over one or more complete lactation periods, it has been found that the adjustment of the ration by the addition of salts present in too small amounts has resulted in a rather greater yield of milk and in an increase in breeding capacity and decrease in disease.

Some interesting cases of deficiencies of one or more minerals in natural pastures have been discovered. In an investigation being carried on partly at the Rowett Institute and partly at the Nutrition Institute at Cambridge, it has been found that there are marked differences in the mineral content of uncultivated pastures grown in different localities, and that there appears to be a correlation between the mineral content of the pasture and its feeding value, as determined by the number of stock it can carry, and the health and breeding capacity of the stock. An interesting fact brought out is that, where the sheep have a choice of pastures, they actually eat the herbage the mineral composition of which most closely approximates to that of good cultivated pasture. As we saw above, good pasture contains the various elements in proportions somewhat similar to those which are found in milk, and might therefore be presumed to be suitable for growth and the maintenance of health, as indeed is found to be the case in practice.

In various countries where the modern type of rapidly growing animal has been put to graze on uncultivated pastures, malnutrition, as shown by stunted growth, low milk yield, or increased liability to disease, has appeared. Thus, in South Africa, Sir Arnold Theiler and his associates have shown that deficiency of phosphorus in the pastures is the cause of pica (depraved appetite), which is prevalent in cattle in certain districts there and leads to the ingestion of the organism which causes lamziekte, and that the condition can be prevented by feeding bone-meal, or any foodstuff rich in phosphorus. Not only does this adjustment of the mineral intake prevent the disease, but the general condition of the animals is also improved.

The two elements most frequently deficient in pasture are probably calcium and phosphorus. Malnutrition due to deficiency of these has been noted in various districts in Australia, New Zealand and India, and in the Falkland Islands. Other minerals may, however, also be deficient. Thus, in the North Island, New Zealand, Aston has found that deficiency of iron is the cause of malnutrition in animals which are grazed continuously on certain areas. The condition is avoided if the animals are transferred for a time to an area where the pasture is richer in iron. The symptoms of the disease can be relieved by feeding iron salts. It is probable that a similar condition

occurs in parts of the Cheviots where soil conditions are similar and the sheep show symptoms which resemble those described by Aston.

These examples of malnutrition in stock, associated with deficiency of one or more mineral elements in the food, are sufficient to show that the dietary conditions which produce such forms of malnutrition are fairly widespread. They also show that there is a possibility of remedying the defects if the nature of the deficiencies be known.

In order to be able to make the necessary adjustments, it is necessary to know the amounts of each of the minerals which should be present in the ration to meet the requirements of the animal. But this depends on the extent to which they are absorbed from the alimentary canal. There might be an abundance in the food, but owing to factors which affect absorption adversely, only a small proportion of what is present in the food may pass through the wall of the intestine into the metabolic field. For example, in the case of calcium, which is probably the element which involves most difficulty in this respect, the amount absorbed, as calculated from the intake in the food minus the output in the faeces, may vary from nil to over 80 per cent. of the amount ingested.

Excess or deficiency of one mineral element may interfere not only with the absorption but also with the utilisation of another. Thus, for example, excess of magnesium interferes with the assimilation of calcium, the ratio of sodium to potassium affects the assimilation of both calcium and phosphorus, either too much or too little oil in the diet decreases the amount of calcium absorbed from the intestine. So the ratios of the different minerals to each other and to the organic constituents of the food are almost as important as their absolute amounts.

Recent work on the ultra-violet irradiation of animals is of great importance in this connexion. The beneficial effects of sunlight have been recognised for many generations. Within the past few years it has been shown that the beneficial effect of sunlight in nutritional diseases such as rickets can be obtained from artificially produced ultra-violet rays.

At the Rowett Institute we have found that when animals are subjected to the influence of these rays the amounts of calcium and phosphorus absorbed from the intestine tend to be increased, or at least the amount excreted in the faeces is decreased, even though at the same time the amount excreted in the urine may be increased. This result, which has an important bearing on mineral metabolism, has also been obtained by other workers. It is of interest to note that the influence of irradiation on the absorption of minerals from the intestine appears to be greatest when the diet is badly balanced.

Ultra-violet irradiation is probably of very great practical importance in milk production. It has been shown by balance experiments that there is difficulty in preventing a loss of calcium from the body of the cow at the height of lactation, when the cow is fed indoors, and there is reason to believe that this loss of calcium is a predisposing cause of some of the diseases prevalent among high-milking cows. It has been found that irradiation at the height of lactation

can decrease the loss of calcium in goats, or even convert a negative balance into a positive. The practical value of irradiation will, however, not be demonstrated until experiments have been carried out with large groups of stall-fed cows in winter, to determine whether the irradiation will favourably affect milk yield, breeding capacity and health.

From what has been said regarding factors which affect the assimilation of minerals, it will be readily understood that, before the mineral content of a ration can be adjusted, it is necessary to consider all the existing dietary factors. Even when all this has been done, it is impossible, in the present state of our knowledge, to do more than make an empirical adjustment by adding inorganic salts containing elements thought to be deficient in the ration. In a few cases we can predict, with some degree of certainty, that beneficial results will follow such adjustments, but in most cases the attempt must be regarded as an experiment, the results of which may or may not justify the continued use of the salt mixture tried.

It is obvious that the use of a stereotyped salt mixture with different rations, and for animals of different ages, and even of different species, is not warranted. In feeding experiments errors arise from the assumption that the addition of such mixtures obviates any necessity for further consideration of the mineral requirements of the animal, or of the influence which may be exercised by inorganic salts present in foodstuffs, the value of which is being tested. Under practical conditions, the use of such fixed mineral mixtures proves beneficial in many cases because they are rich in those inorganic constituents which are most frequently deficient in concentrates, but in cases where the ration is already rich in some of the minerals present in the mixture, the resulting excess may be harmful. No mineral mixture is a panacea.

Our knowledge of this subject is, therefore, still so scanty that it forms a very uncertain guide to the stock-farmer. It is sufficient, however, to warrant his testing, under practical conditions, some of the results which have been obtained under experimental conditions. The results of such tests, if positive, would secure the early application in practice of information which we already possess, and, whether positive or negative, would be a valuable guide to further efforts to increase that part of our knowledge which is of immediate practical value.

Though this practical experimental work is important because it may yield results of immediate economic value, yet with regard to the future it is not more important than academic research. Valuable results are likely to be yielded by further investigations being carried out on the interactions of colloids and inorganic ions, on the influence of the electrical charge and chemical characteristics of the ion on these reactions, on the effects of radiant energy on the processes associated with mineral metabolism, and on the relationship of these to both normal and pathological processes in the body. In this region, which we have only begun to explore, there seems to lie the key to the solution of many obscure problems, both of the normal metabolism of health and the abnormal metabolism of disease.

The Discipline of Chemistry.¹

By Prof. CECIL H. DESCH, F.R.S.

TWO tendencies are clearly visible in the chemistry of to-day, and are profoundly affecting our methods of study and instruction, and also the direction of research. On one hand, chemistry, like every other science, is being split up into a number of distinct specialisms, and workers are tempted or even compelled to confine themselves to a narrow field; on the other, the boundaries between the several sciences are becoming less definite, through the development of border sciences, which themselves become new specialisms. In so far as it is possible to arrange the abstract sciences, in a linear series, chemistry may be said to depend upon physics, as the biological sciences in their turn depend upon chemistry, the theoretical part of each being built up on the established laws of the preceding science as a basis. Physics has gone far to provide the required basis for chemistry, and each new advance in physics suggests new ideas in chemistry. Chemistry in its turn is providing a basis for biology, although more slowly than had been hoped. Great as have been the triumphs of organic synthesis and of investigations of the colloidal state, the chemical study of living organisms is still looking to chemistry for more help than it has yet received.

Whether we look at the serious publications dealing expressly with the progress of science or at the mass of popular articles in newspapers and periodicals, we see that the centre of interest at the present day lies in the new discoveries and hypotheses of physics. There is no question but that the structure of the atom, the theories of relativity and of quanta, the existence of the ether, and the results of the examination of crystals by means of X-rays, interest the educated public more deeply than any questions in chemical or, probably, in biological science. On the other hand, there is little public curiosity in regard to the advance of chemical science. A few of its applications, and those mainly concerned with warfare, attract attention from time to time, although the progress of agricultural chemistry, the most important of all from a national point of view, is shamefully neglected, in spite of the admirable work which is being done at Rothamsted and elsewhere. The public interest in chemistry does not extend far beyond poison gases and dyes. The progress of pure chemistry and the development of chemical theory are followed only by a small body of specialists, engaged in teaching or research, and of students whom our present system of scholarships and degrees forces more and more to become specialists, even at a very early stage of their studies. Perhaps this state of things is responsible for a certain attitude concerning the future of chemistry which may be traced, in implication rather than expression, in the work of some chemists at the present day. It appears to be thought that chemistry is fated to become a branch of physics, and thus to lose its own peculiar discipline, leaving its long-established methods to chemists engaged in operations of a routine character, whilst new knowledge is being acquired by the application of physical

methods of experiment, and interpreted by the methods of mathematical physics.

The knowledge of the internal structure of the atom, and consequently of the manner in which atoms may unite chemically with one another, has advanced with such extraordinary rapidity that it has seemed that chemical facts must henceforth be regarded in an entirely new light. If we accept the view that protons and electrons are the units of which all atoms are composed, the forces between them being purely electrical, and that the whole system of the chemical elements may be built up in a perfectly regular and systematic fashion from these units, whilst the structure of each atom enables us to predict how it will enter into combination with other atoms, then it would seem that chemistry should in course of time become a purely deductive science. If such a state of things were to come about, experiment in chemistry would be unnecessary, since all facts could be deduced from certain general principles and from fundamental physical constants which would by then have been determined with great accuracy. Chemists, however, know that this is not how their science has advanced or is likely to advance. Chemistry is an experimental science, which progresses by the application of a definite discipline, obtaining conclusions by induction from the observed facts, and making use of deduction from a small number of well-tried hypotheses where required.

Granting the theoretical possibility that atomic theory might become so perfect that the facts of the chemical structure of molecules might be deduced from a comparatively limited mass of data, it would nevertheless remain true that the labour of such deduction would be beyond human powers, except in relatively simple cases. We can scarcely imagine the properties and synthesis of indigo being deduced from the internal structure of the atoms of carbon, nitrogen, oxygen, and hydrogen, although it is possibly true that the one is implicit in the other. Human intelligence is not equal to the task, nor does it seem likely to be so in the future.

Chemical science has been responsible for the introduction of a number of hypotheses which have survived to the present day, and it may be worth while to look at them for a moment. The doctrine of atoms was not a chemical invention, but there is a vast difference between its use among Greek philosophers as a means of satisfying their desire to find a consistent explanation of the universe and its scientific application in the hands of Dalton as a means of explanation of the quantitative facts of chemical combination. There has been some discussion as to Dalton's personal attitude on this question, but there can be no doubt that those who did most to establish the doctrine attached no metaphysical importance to it, but used it frankly as an hypothesis to explain known facts and, above all, to predict new facts.

It is probable that throughout the nineteenth century it was a matter of comparative indifference to most scientific chemists whether atoms had a real existence. All that was important was that matter behaved as though it had an atomic structure, and that no fallacies

¹ From the presidential address, entitled "The Chemistry of Solids," delivered on August 31 at Southampton before Section B (Chemistry) of the British Association.

or errors were introduced by making such an assumption. The value of the atom to them was quite independent of any possible demonstration of its real existence. Gradually, as the conception of atoms and molecules was found to fit a larger and larger field of facts, confidence grew, and atoms came to be regarded as real, in the only sense in which the scientific experimenter can understand reality. Molecules, built up of atoms according to well-established laws, shared in this confidence, which was thoroughly justified by the remarkable concordance of the determinations of Avogadro's number, the number of molecules in the gram molecule of a substance, as arrived at by a number of totally independent methods.

The discovery of radio-activity, whilst enlarging the conception of the atom, has made it possible to isolate the effects of single atoms travelling at a high velocity, so that the impact of a single α -ray on a fluorescent screen produces a visible effect, and the counting of these rays, which are known to be charged helium atoms, corresponds perfectly with the original hypothesis. When the minuteness of the atom was realised, chemists cannot have dreamed that a day would come when the effect of so extraordinarily minute a particle could be perceived by the eye and even exhibited on a screen to an audience. No more extraordinary confirmation of the soundness of the theoretical views of the chemists of the early nineteenth century could have been received.

Next came the development of structural theory, with reference to organic compounds, associated with the names of Kekulé, Couper, Crum Brown, and Butlerow. Again the assumed arrangements of atoms in compounds were adopted in order to express the reactions of the substances, without reference to the real existence of the chains of atoms represented in the new formulæ. Within the last few years the study of the films of fatty acids and similar substances on the surface of water by Langmuir, Hardy, and Adam has shown that the properties of such films can only be accounted for by assuming the reality of those chains of atoms which served so well the purposes of the chemist, but seemed physically improbable. The examination of solid fatty acids by means of X-rays leads to exactly the same conclusion. The greatest triumph of structural theory, the hexagon formula for benzene, need only be mentioned in passing, since it is only a month or two since the celebration of the discovery of benzene by Faraday, when the wonderful chemistry of the aromatic compounds was eloquently described by Sir William Pope and Prof. Armstrong. Next came the generalisation known as the periodic system of the elements, due mainly to Mendeleëff and to Lothar Meyer, and finally the hypothesis of the tetrahedral arrangement of the atoms around a carbon atom, devised by van 't Hoff and Le Bel to account for optical isomerism. Modern X-ray methods show that the structure of crystals of the corresponding substances is fully accounted for by assuming that the benzene hexagon and the tetrahedral linking of carbon are actually present, and the interpretation of crystals has been made possible and unambiguous by the existence of so great a mass of fully established chemical data.

The point which I wish to make is that these hypo-

theses, of the chemical atom, of the molecule, of the chains and linkings represented in the graphic formulæ of organic compounds, of the hexagonal ring in aromatic substances, and of the tetrahedral carbon atom, were introduced without reference to any metaphysical conception of the nature of matter, and were independent of any dogma concerning reality. They were intended as working hypotheses, connecting and co-ordinating facts which had been discovered by the classical methods of chemical experimentation. That they have been confirmed by entirely independent physical means shows how sound was their foundation, and encourages us to suppose that the same methods which have served so well in the past may again be trusted to lead to new discoveries in the future.

The remaining example which I have mentioned, the periodic law, was regarded by many chemists as a convenient means of arranging the facts of inorganic chemistry, but was expressly stated to be only empirical, since a theoretical basis was inconceivable. The work of Moseley, the discovery of the radioactive elements, and the conception of isotopes, have shown the periodic classification to be the most fundamental thing in the chemistry of the elements, and the atomic number has been found to have greater theoretical significance than the atomic weight. Reference to isotopes reminds us that this discovery also was made by chemical means, although its investigation appears almost to have passed out of the hands of the chemist into those of the physicist, since the introduction of the positive ray method of analysis. It was the chemical work of Soddy, Russell, Fleck and Fajans, establishing the fact that two or more elements, differing in atomic weight but identical in chemical properties, could occupy the same position in the periodic classification, which opened up this new and extraordinarily important and interesting field of research.

The development of the theory of atomic structure, due mainly to Bohr, has necessarily affected modern views of chemistry. The theory was devised to explain the phenomena of radiation, and later proved to accommodate itself in a wonderful manner to those of chemical union, making use for the purpose of Werner's doctrine of co-ordination. In its new form it promises to do much to reduce to order the facts of inorganic chemistry, still so far behind the organic part of the science in the perfection of its logic. The static atom of Langmuir, now abandoned, played an important part in bridging over the gap between the planetary arrangement, chiefly suited to the explanation of spectra, and the present highly developed system.

Whilst recognising the immense value of the new ideas, may I once more venture to utter a word of warning? The modern student tends to specialise in his scientific studies at a very early stage, and, if introduced in detail to the new conceptions while still engaged in learning the elementary facts of chemistry, is likely to suppose that the facts depend on the theory, instead of the opposite being true. The danger may seem to be exaggerated, but it is nevertheless real. I would submit that the facts should be known to the student before he applies to them this interpretation, which may prove so fascinating as to distract his attention from the experimental basis of the science.

The Discharge of Electricity through Vacuum Tubes.¹

By Prof. R. WHIDDINGTON, F.R.S.

DISCHARGE tubes with cold electrodes and low gas pressure present a great variety of complex phenomena which, at the time of their discovery, were most difficult to explain. Many of these old difficulties remain, but some have been cleared away or are in process of being cleared away in the light of recent work. In any event, within the last few years sufficient new points of view have been put forward and fresh phenomena discovered to warrant recollection of the past and special notice of the present.

With the gas pressure in the neighbourhood of 1 mm. of mercury and the discharge passing along a straight cylindrical glass tube furnished with plane electrodes, the appearance shown diagrammatically in Fig. 1 is presented. For convenience we may consider the discharge under three headings.

1. *The cathode region*, comprising the softly luminous cathode glow, the Crookes' dark space and the negative glow.

2. *The anode region*, consisting of a very thin layer of light over the anode surface.

3. *The central region of the tube including the positive column* continuously glowing, sometimes striated, separated from the cathode region by the Faraday dark space and extending right up to the anode.

These are the usual, easily recognisable divisions of the discharge with cold electrodes and a steady applied potential of a few hundred volts.

Speaking generally, the current passing through the tube will be carried almost entirely by electrons and positive ions, negative ions being comparatively unimportant. Owing to the difference in nature of these two types of carrier, however, and their interdependence, important space charge effects within the tube and area charge effects on the walls are set up, which play an important part in determining the electric forces and thus the nature of the discharge. We shall outline these and other matters in what follows.

1. The Region of the Cathode.

The cathode is the seat of origin of the very speedy electrons—the cathode rays—which often possess a velocity little short of that given by the usual relation

$$eV = \frac{1}{2}mv^2,$$

where V is the potential difference between the cathode and the edge of the dark space—the so-called cathode fall.

The dark space edge is inexplicably sharply defined and is imagined to represent the region where there is not only ionisation by the cathode rays but also recombination resulting in light emission. This is probably bound up in the fact that the electric field in the dark space has a high value whereas in the glow the field is very much smaller.

This matter of the value of the electric field is of great importance in the theory of the discharge. Measurements, whether made by the much criticised probe method or by Aston's transverse cathode ray method, show that the axial field X increases linearly with distance from the dark space boundary to the cathode. Brose, by a most ingenious method based on

observations on the Stark effect in the weak light emitted from the dark space region, has recently shown that *very close* to the cathode there is a sharp drop in the electric field. This is shown in an exaggerated manner in Fig. 1. This state of affairs in the dark space is regarded as due to the space charge effects.

It was shown long ago by Schuster, Wehnelt and others by placing obstacles in the dark space that there was a "shadow" thrown both ways, so to speak, the supply of electrons from the cathode and the positive rays approaching thereto being simultaneously cut off. It was inferred that the main supply of electrons from the cathode arose somehow from the arrival there of positive ions originating in the edge of the negative glow. We conclude therefore that, since the speed of the ions is so much smaller than the electrons, there will be, on the whole, a concentration of positive

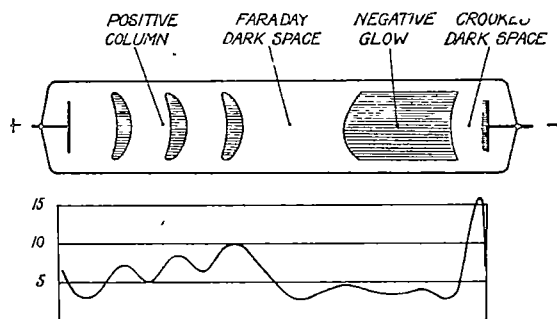


FIG. 1.—Diagrammatic representation of the regions in an exhausted tube, with, below, a curve showing the changes in the electric field in passing along the tube

electricity in the dark space. We should thus be able to obtain an expression for the variation of X by applying Poisson's law,

$$\frac{dV}{dx} = -4\pi\rho,$$

in much the same manner as in Langmuir's well-known application to the thermionic valve.

The form of the expression obtained, however, will clearly depend on the assumption made as to the distribution of positive electricity in the dark space. Assuming an impartial distribution of the positives in the dark space—an assumption incidentally not in accord with the generally accepted view of ion production outlined above—Sir J. J. Thomson deduces an expression for the electric field in accordance with the experimental results of Aston.

Very close to the cathode, on the other hand, the expression would scarcely be expected to hold, since here, production of electrons by ion bombardment is taking place, resulting in a negative space charge and a consequent lowering of the field. This brings Brose's experimental result into line.

It is interesting to note in passing that it is not an entirely straightforward matter to explain how electrons are produced at the surface of the cathode by positive ion impact. For although the whole energy of the approaching ion is adequate, this energy can only be handed over in part—and a very small part, a consideration which, when taken into account quanti-

¹ Substance of three Tyndall Lectures delivered at the Royal Institution on May 19, 26, and June 2.

tatively, leads to the result that insufficient energy to effect ionisation is actually available.

The most likely explanation appears to be that the ion on reaching the cathode captures an electron, radiates at the appropriate frequency, and it is this radiation which ejects from the cathode low speed electrons destined to form the cathode rays. We should expect on this view that the heating effect at the cathode would represent nearly the whole energy of the incident positive rays, an expectation in accordance with the facts.

2. The Anode Region.

Just as there is a jump of potential near the cathode in passing across the dark space, so there is an anode fall of potential.

The anode fall, however, appears to be capable of easy explanation. It is not at all dependent on the nature of the electrodes but only on the gas and on the current flowing. Moreover, as the current is diminished the anode fall rises to a constant value which approximates very closely to the ionisation potential of the gas.

We conclude, therefore, that the cloud of negative electrons near the anode produces this anode fall, and that at small currents its nature is such that single impact ionisation occurs at the anode surface, this ionisation taking place perhaps in a film of gas on the electrode. At high current densities the anode fall diminishes, probably because cumulative ionisation then takes place.

3. The Central Region of the Tube.

The positive column which occupies the central portion of the tube is in many respects the most puzzling part of the discharge. Separated from the negative glow by the Faraday dark space and extending right up to the anode, its character is usually independent of the length or shape of the tube; it is sometimes a uniform column of light, sometimes—particularly when the gas is impure—striated. The conductivity of this region is high and the electric force small.

It has usually been supposed that for the continuous positive column there is a copious supply of electrons moving with ionising speed under an electric field partly determined by the space charges and partly by the charges on the wall of the tube. It is clear that the electrodes themselves cannot contribute, directly, at all to this field.

The emitted light has been supposed to be due to ionisation and subsequent recombination, which latter process is encouraged by the small electric field—in contradistinction to the state of affairs in, for example, the Crookes' dark space. The striations have been supposed to be a repetition of the state of affairs near the cathode, the non-luminous spaces between the striations being the equivalent of the Faraday dark space.

It is an interesting fact, however, that even with the perfectly steady potential from a battery of storage cells applied to the tube, it is very usual to find that the current itself is regularly intermittent, a phenomenon which has been known for many years but has never been explained.

I pointed out recently (*Proc. Camb. Phil. Soc.*, 1924) that this effect is particularly marked in the case of the discharge through argon, and that if the tube be

made of quartz and a current of several amperes passed to produce a brilliant luminosity, then most beautiful effects are observed if the tube be viewed in a mirror rotating rapidly about an axis parallel to that of the tube. Fig. 2 is an untouched reproduction taken from an instantaneous photograph obtained in this way. It will be seen that the appearance presented is that of a number of straight, parallel equidistant lines inclined at an easily measurable angle with the horizontal. The heavy horizontal line is a superimposed photograph of the glowing tube viewed in the mirror at rest. The narrow vertical line on the extreme right of the equally spaced markings is a photograph, in the same spinning mirror, of a little mercury vapour lamp fed with alternating current of about 40,000 frequency from an oscillating thermionic valve.

Interpreted broadly, this photograph shows that, so far as the luminous character of the discharge is concerned, flashes of uniform speed follow each other at equal intervals of time down the tube moving from anode to cathode. Their velocity and frequency past

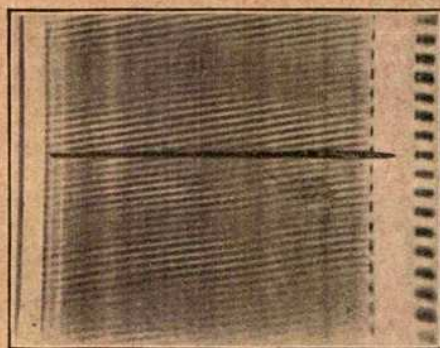


FIG. 2.

any point in the tube may be calculated from their inclination and distance apart.

When it is remembered that these discontinuities in the discharge occur with a steady applied potential and are practically independent of any capacity, inductance or resistance, included in the circuit, it will be seen that the phenomenon is well worth remark and further investigation. It is intended at the moment to give only a very general account and explanation so far as the available experimental evidence will allow.

In the first place—as might be expected on almost any reasonable theory—the velocity of the flashes increases as the gas pressure is reduced, being nearly proportional to $1/p$. For a given strength of electric field this is what is to be expected if the moving flash consists of or is associated with moving electrons or ions. The speed is, however, also determined in part by the strength—or rather average strength—of the current, increasing somewhat with greater currents. At the same time the frequency—indicated by the distance apart of the flashes—also increases as the velocity increases, in many cases, in nearly the same proportion.

A highly important fact which came out quite early in the experiments is that the emitted light, when examined with a spectroscope of high resolving power (a spectroscope fitted with a Fabry and Perot étalon), shows no signs of the Doppler effect. That is, when

the spectrum is viewed at right angles to and along the axis of the tube, there is no detectable change of wavelength in any of the lines suitable for examination. Had the sources of emission been moving with the speed of the flashes an effect should certainly be observable.

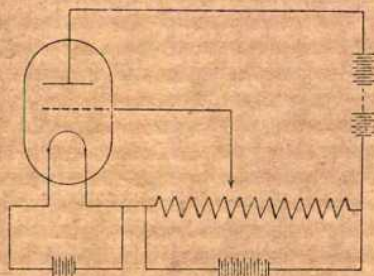


FIG. 3.

I think that an explanation (although another is possible) of this flash phenomenon may be based on a rather similar effect I chronicled in 1919 in the late *Radio Review*. If an ordinary thermionic valve con-

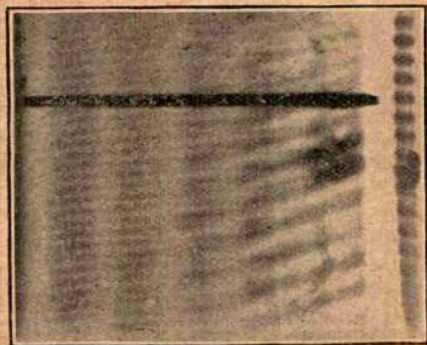


FIG. 4.

taining a trace of mercury be linked to a non-inductive circuit as in Fig. 3, then if the potential (V) applied to the grid be varied between certain limits, the current in the valve circuit oscillates at a frequency (n) such that n^2/V is constant. It was shown that the effect can be satisfactorily explained on the reasonable supposition that there is some particularly active electron-emitting point on the valve filament which, when bombarded by positively charged mercury ions, emits still more vigorously (whether by space charge neutralisation or by local heating is immaterial to the general idea); the result is that there are set up regular sequences of electrons flowing to the grid in a negligibly small time and positive ions produced in the region of the grid and falling back to the filament. The time taken by these positives in travelling from grid to filament determines the oscillation frequency. In the note referred to, it was

shown that a quantitative explanation along these lines is possible.

It would seem that a similar explanation might be made in the case of the flashes in the long discharge tube. The anode, on this view, would be the seat or origin of the flashes. We suppose a cloud of electrons round the anode; only those starting from a certain minimum distance will ionise at the anode surface. As soon as this occurs a sheet of positive ions will move away from the anode at a speed determined by the electric field, but the presence of this positive sheet constitutes a space charge which will so reduce the field in its train as to prevent further ion production; it therefore moves away as an isolated sheet of ionisation—to be followed in due course by a similar one produced in a similar manner. Why is not the Doppler effect observed? The suggestion is that the visible light emitted is not due to these moving ions but is a state of affairs produced by them. We must imagine that invisible radiation is given out which excites (possibly without ionising) the relatively immobile atoms of gas past which the radiating ions move.

There is some evidence, however, which it is not proposed to discuss here, in favour of a modified view of the ordinary discharge recently propounded by Günther Schulze. This investigator suggests that where a stream of electrons moving with high speed encounter and ionise (or excite) gaseous atoms, the spent electrons may produce a space charge. I merely wish to mention here that it is possible to give an alternative explanation along these lines but at the same time to point out that it is by no means impossible that both mechanisms operate, according to the conditions obtaining within the tube.

When the gas in the tube is pure it is usual to observe the appearance shown in Fig. 2, but after the discharge has passed for some time, there appear in the rotating mirror two sets of flashes; those at the anode end being much steeper, *i.e.* more slowly moving, than those at the cathode end. A reproduction of a photograph of this kind is shown in Fig. 4.

I believe this to be due to the presence of a little hydrogen. If the spectrum of the light emitted be

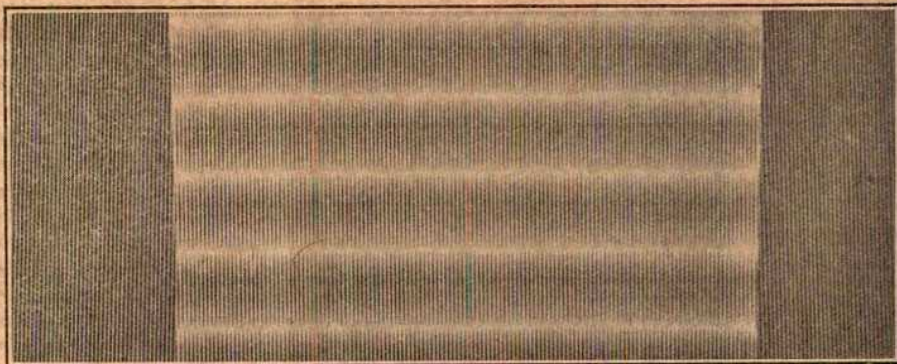


FIG. 5.—Two coarse-ruled gratings superimposed with lines slightly inclined to each other.

examined, it is found that near the anode the spectrum of hydrogen is strongly developed, while near the cathode it is absent or very weak. Now the slopes of the two sets of flashes are such as to suggest that the slow ones are due to argon ions and the fast ones to

hydrogen ions. This at once suggests a reason for the spectrum distribution just mentioned, for where the fast flashes occupy the tube, all or most available hydrogen will be taken up in the form of non-luminous ions and the radiation they emit will only have argon atoms on which to work. The hydrogen spectrum will therefore be weak or invisible.

So far we have been walking on fairly solid ground, but it is interesting to observe in conclusion that the definite experimental proof of the existence of these two sets of flashes through an impure gas may be made the basis of a somewhat speculative suggestion as to the origin of the familiar vacuum tube striations. We have only to suppose that in the impure gas there are two sets of flashes moving with different speeds and in simultaneous existence along the tube and we

get at once that if the velocities are related in a certain manner, continuous steady striations occur where the two sets cross. An example of this combination effect is shown in Fig. 5, which is a photograph of two coarse-ruled gratings with their lines slightly inclined to each other. The edges of this photograph clearly show the lines of the two gratings separately and the central part where they are superimposed. The horizontal equidistant bands in this superimposed area are parallel to the shorter diagonals of the parallelograms produced by the intersections of the two sets of mutually inclined lines, and, according to our speculation, would represent the striations as seen in the rotating mirror. Further experiments, however, must be performed before anything more definite can be put forward.

A Cotton Research Station for the British Empire.¹

IT has long been a weak point in the scientific investigation of the agriculture of the British tropical dominions that we have had no stations where problems that are fundamental and underlying, affecting all tropical countries alike, could be attended to: Local departments of agriculture are necessarily and rightly occupied with local questions, and authorities might look askance at such a department if it were to devote itself, for example, to the fundamental problem of the connexion between lint characters in cotton and spinning qualities.

This defect in our organisation is now to be removed, so far as cotton is concerned, a forward step of great importance having been taken by the Empire Cotton Growing Corporation, which, with the express aim in view of the solution of problems of this nature, has decided to open in Trinidad a cotton research station, near the Imperial College of Tropical Agriculture. The station is to be provided with a first-rate staff, and well endowed with funds, so that great results may be expected from this far-seeing enterprise.

"It is intended to investigate there the cotton plant in all phases of its growth and under rigorously controlled conditions, so that it may be possible to ascertain and to estimate the importance of the several factors which contribute to the final result." In other words, it is in no sense intended as a local station for the investigation of problems which are of local origin and can only be solved under corresponding local conditions, nor is it intended as a place for the breeding of pure-line seed upon a large scale. Such seed, with various special characteristics, will indeed be produced, but when it is introduced into other places, the effects of acclimatisation (at present not understood) will come in, and it is for each individual country to produce from the seed the cotton that is best adapted to its local conditions. Much labour in breeding will thus be saved to the local workers, for they will start from seed of known genetic qualities. The new station will not relieve the local agricultural departments from the necessity of scientific work upon their local problems, but will provide them with better fundamental knowledge upon which to base their investigations.

Since it was decided to establish the station, a strong committee has been at work considering the claims of

various places in the warmer parts of the British Empire, and at last, by a process of gradual elimination, decided that Trinidad was the most promising. Prof. J. B. Farmer and Mr. L. G. Kilby (secretary of the Corporation) were then sent out to report in more detail, and as a result Trinidad has been finally selected.

In his preface Dr. W. L. Balls directs attention to the fact that it was the late Mr. J. W. McConnell (first chairman of the Council of the Corporation) who was chiefly responsible for the achievement of this result—a result which even ten years ago would have been considered Utopian.

Trinidad is suited, in the neighbourhood of Port-of-Spain, to the cultivation of cottons of many different kinds, but has not proved commercially successful in their growth, so that the cottons upon the station will not be liable to hybridisation with others growing near by—an important advantage. It is easily accessible from England, and from the other countries of the American continent where cotton is cultivated on the large scale. It has a good and healthy climate, and the site chosen is near to the capital town, while it is also near to the Imperial College of Tropical Agriculture, thus placing its staff in close contact with the workers in the latter, and with the facilities there provided. This is another advantage of great importance to both parties, especially as a good many of the future employes of the Corporation are trained at the College, and will thus have the station near at hand, and be in a position to get upon friendly terms with the staff, from whom they will be able to get useful hints in their work.

The site is an area of sixty acres, about one-third of which will be planted in cotton every year, with cane as a rotation. It is proposed that work be begun by the appointment of a geneticist and a plant physiologist, each with a competent understudy and the needful assistance, including frequent study-leave and travel. The management and general direction it is proposed to entrust to a local advisory committee of two—Dr. H. Martin Leake, Principal of the Imperial College, who has done much research work upon cotton, and Mr. W. Nowell, Assistant Director of Agriculture in Trinidad, well known for his work in mycology, etc. These gentlemen will act in their private and not in their official capacity. It is also hoped to arrange for exchanges of staff with the Shirley Institute of the British Cotton Industry Research Association.

¹ Summary of a Report to the Empire Cotton Growing Corporation, by Prof. J. B. Farmer and Mr. L. G. Kilby, with a foreword by Dr. W. L. Balls (London, 1925).

Obituary.

PROF. F. R. JAPP, F.R.S.

FRANCIS ROBERT JAPP was born in Dundee on February 8, 1848, his father being the minister of the Catholic Apostolic Church in that city. His early academic training gave little indication of his ultimate career, for after graduating in arts at the University of St. Andrews he entered the University of Edinburgh as a student of law in 1868. Ill-health, unfortunately, soon led to an interruption of these studies and to a fairly long period of foreign travel and residence, mostly in Germany, and it was not until the autumn of 1873 that Japp definitely settled down to the study of chemistry in Bunsen's laboratory at Heidelberg. He completed his curriculum at that university by graduating as doctor of philosophy in 1876, and afterwards proceeded to Bonn, whither the fame of Kekulé attracted chemical pilgrims from all parts of Europe. In his Kekulé Memorial Lecture, delivered before the Chemical Society in 1898, Japp paid eloquent tribute to the inspiring genius of this great chemist. While in the Bonn laboratory, Japp worked more especially under Schultz and Anschütz, and papers were published jointly with each of these investigators.

In 1878 Japp returned to Great Britain, and after working for a short time in Crum Brown's laboratory in Edinburgh he became research assistant at the Normal School of Science, South Kensington, under the late Sir Edward Frankland. At the reorganisation of the Science Schools in 1881 he was made assistant professor in the department of chemistry, and this post he continued to hold until his appointment in 1890 to the chair of chemistry in the University of Aberdeen, as the successor of Thomas Carnelley. During his tenure of the London post, Japp devoted himself with great industry and enthusiasm to the prosecution of research in organic chemistry, and in the decade 1880-1890 he published, either in his own name or conjointly with his pupils, about forty papers dealing largely with phenanthraquinone and other diketones and their derivatives. This activity in research was recognised by election into the Royal Society in 1885, and by the award of the Longstaff medal of the Chemical Society in 1891. For six years, moreover, he acted as foreign secretary of the Chemical Society, of which body he was later a vice-president for two periods.

At the time of Japp's arrival in Aberdeen the reconstruction and extension of the chemistry department were overdue, but for several years the work had to be carried on in the old, ill-ventilated, badly lighted laboratories. In spite of this, Japp, who was pre-eminently an investigator, contrived to prosecute and encourage research work, and it was perhaps his chief service to the northern university that he fostered the spirit of original investigation and inquiry in a none too favourable environment. During his tenure of the Aberdeen chair, covering the period 1890-1914, about forty memoirs emanated from the chemical laboratories there.

The character of this, as well as the earlier research, was such as to attract the notice mainly of specialists; but Japp's address on "Stereochemistry and Vitalism," delivered in 1898 in the capacity of president of the

Chemistry Section of the British Association, made a much wider appeal, and gave rise to an animated discussion in the columns of NATURE. The thesis put forward in the address, and defended with much suggestiveness and resource, embodied a development of Pasteur's view that "the production of single asymmetric compounds or their isolation from the mixture of their enantiomorphs is the prerogative of life. Only asymmetry can beget asymmetry."

This sketch would be incomplete without some reference to the very wide scope of Japp's interests. Primarily a chemist, he possessed marked literary, artistic, and linguistic talent, and the British Association address already mentioned furnishes ample evidence of his broad philosophic outlook and of his well-stored mind. An accomplished linguist, he was familiar with much of the best in the literatures of Germany, France, and Italy, as well as of his own country, while on the artistic side he was a musician of knowledge and taste.

After relinquishing the Aberdeen post, Japp lived quietly in retirement in London until his death on August 1 last. Latterly a semi-invalid, he was dependent on the unremitting care and attention of the widow and two daughters who remain to mourn his loss.

J. C. P

PROF. OTAKAR KUKULA.

THE Charles' (Bohemian) University of Prague lost on August 11, at the relatively early age of fifty-eight years, one of its most eminent professors, namely, Prof. O. Kukula, professor of surgery, director of the first surgical clinic, and at the same time Rector Magnificus of the University. Prof. Kukula's clinic was equipped in the most modern way, and he was in close touch with internal chemical as well as biological methods of investigation, so that his chair was a model of its kind. As a surgeon he was unsurpassed, being able to carry out surgical operations of the most difficult and delicate kind with the greatest ease and calm. He not only studied all known good methods of operation, but also introduced many new and the most difficult ones, and he was well known for this in scientific circles abroad as well as at home.

Prof. Kukula published in Bohemian, French and German more than forty scientific papers, of which only those on stones in the bladder and on the surgery of the kidneys need be mentioned. His great work, "Pathology and Therapy of the Inflammation of the Appendix," is a remarkable monograph, finding its equal only in the work of Kelly.

Prof. Kukula was a member of the Bohemian Academy and of many foreign scientific societies, and he was also the founder and president of the Czechoslovak Automobile Club. He rendered great services to the Serbs in the war with Turkey and was decorated with the highest Serbian orders.

BOHUSLAV BRAUNER.

WE regret to announce the following deaths:

Prof. E. H. Barton, professor of physics, University College, Nottingham, on September 23, at sixty-six years of age.

Don Luis Cubillo y Muro, director of the Geographic Institute of Spain and president of the Spanish National Committees of Geophysics and of Astronomy, on July 10.

Current Topics and Events.

PARTICULARS of the fifth Congress of Industrial Chemistry, organised by the Société de Chimie Industrielle, are now available. On October 4 there will be an official reception, followed by a musical soiree, in the Hôtel Majestic, Paris. The following day, the Minister of Public Instruction will open the congress in the Conservatoire National des Arts et Métiers, where the international exhibition of the decorative arts is being held, and where all the subsequent meetings will be held. At the opening ceremony, M. L. Guillet will give an address on the rôle of French science in metallurgy. Sir Robert Hadfield is contributing a valuable paper on French scientific investigators and institutions and on some unsolved problems relating to manganese steel. October 6 will be devoted to conferences on fuels and on metallurgy; October 7 to meetings of the sections, and a banquet in the evening; and on the final day, October 8, the presidents and recorders will meet, and an address on the refining of mineral oils will be given by Prof. H. T. Waterman, of the University of Delft. The remainder of the week will be spent visiting the exhibition, the Renault automobile works at Billancourt, the dyeworks and vanneries at Saint-Denis, or, alternately, to an excursion to Grenoble, where the international water-power exhibition will be in full swing.

ON Sunday, October 11, the centenary of Chevreul's researches on the animal fats will be celebrated in the amphitheatre of the Natural History Museum, Paris, and the proceedings will be honoured by the attendance of the President of the Republic and of the President of the Council of Ministers. In the evening there will be a reception of the foreign delegates. It was in the same place that the anniversary of Chevreul's hundredth birthday was celebrated on August 31, 1886, by the unveiling of a statue to him. On that memorable occasion, Frémy, who followed Chevreul as director of the museum, delivered the principal oration, in the course of which he aptly quoted the saying of Malebranche: "Il faut tendre à l'infailibilité sans jamais y prétendre"; and no less happily, the Minister of Public Instruction quoted the remark which Dumas, the chemist, had made to Chevreul some fourteen years before: "Your work has been the only occupation which has never fatigued you." Chevreul's achievements as an investigator, and as an eclectic philosopher, are inscribed for all time on the pages of history, and on October 11, not only chemists but all followers of science in Great Britain will do silent homage to his memory.

FULLER details of the wreck of the airship *Shenandoah* are now available. The explanation, attributed to a German expert, that relief valves had been removed from nearly half the gas bags, and that their absence would cause disruption, has been dismissed by the U.S.A. official investigator. He attributes the accident to structural failure under the exceptional stresses imposed by a severe local atmospheric disturbance. Controversy is now directed to the

question of effective meteorological service for aeronautics. The reports of the U.S.A. stations are edited by the Weather Bureau of the Department of Agriculture. Information is received daily by telegraph and embodied in the British chart of weather in the northern hemisphere, which shows a shallow depression moving across the great lakes along the line Winnipeg-Chicago-Washington on September 2, 3 and 4. The U.S.A. daily chart, since received in England, amplifies the information and indicates local thunderstorms along the fronts of the disturbance, without suggesting the extreme severity of the conditions developed along the front of the disturbance. The *Shenandoah*, travelling westward from New Jersey on September 2, met the front of the disturbance on the morning of September 3, near Cambridge, Ohio, roughly half-way between Washington and Chicago, and was destroyed. Meteorologists will be of the opinion that ample material for serious warning was available but that the liaison service was inadequate. More precise information, such as an hourly local report from the nearest meteorological stations, would have been required to warn the airship fully of the rapid increase in the severity of the conditions locally. The fact remains that a continental area exposed to numerous severe and sudden storms is not specially suitable for airship services, and the wider question is inevitably raised as to whether the airship is not altogether too fragile a structure on which to place hopes of regular commercial transport services over thousands of miles of land and sea.

THE Imperial Social Hygiene Congress will meet at Wembley on Monday, Tuesday, and Wednesday of next week. The Congress is being organised, as last year, by the British Social Hygiene Council, which at that time was known as the National Council for combating Venereal Diseases. The president is Sir Auckland Geddes, and the patrons include Mr. L. S. Amery, Mr. Neville Chamberlain, Viscount Willingdon and the High Commissioners of the Dominions. In an opening address Mr. Amery will discuss the Imperial aspect of social hygiene. He will be supported by the High Commissioners, and reports will then be received on the administrative, military, and naval position with regard to venereal diseases within the Empire. The afternoon programme includes a statement by Sir Claude Hill, director-general of the League of Red Cross Societies, on methods of health propaganda in Europe and the Far East, and a paper by Dr. H. M. Hanschell on the problem of venereal disease in relation to race and climate. The chief debates on Tuesday will be on the position with regard to venereal disease in Great Britain and self-governing dominions, to be opened by Mr. Neville Chamberlain, and on social hygiene in relation to the mercantile marine, while there will also be a discussion on venereal disease and emigration. The concluding day on Wednesday will be devoted to the consideration of the problem of venereal disease in India and in the Colonies and Protectorates and mandated territories. During the course of the

meeting a number of films dealing with the work of the Council will be exhibited.

WE see by a letter in the *Veterinary Record* that Prof. Hobday is this week taking over to Holland a party of veterinary surgeons and others with the object of showing them that, contrary to general opinion, England in its treatment of such animal products as milk and meat very greatly lags behind many of the continental countries. He has secured the co-operation of a considerable number of veterinary public health officials, and the party, which leaves on Saturday, will include amongst its representatives a number of delegates from those who for years past have been attacking what is generally known as the "decrepit horse traffic." His interest is primarily, according to the statement issued, in the fact that Holland possesses laws (and enforces them) which make it practically impossible for unsound food to be placed on the market. The programme is an interesting one. The party will have every opportunity of seeing the horses as they embark and as they disembark. The members will see the application of the Mallen test, which is compulsory by law, for glanders. Dr. Laurens is enabling them to visit the Serum Institute at Amsterdam, and this visit will be followed by one to a large hygienic dairy at Hillegom, where the cattle are all milked by machinery. On the following day there will be an inspection of the well-known dairy herd of the Netherlands Herd Book Association. The Veterinary School at Utrecht and the Amsterdam abattoir (one of the most up-to-date and modern buildings in existence), with its splendidly organised system of veterinary supervision and its humane methods of killing, will be inspected. On Tuesday, through the courtesy of Dr. Bonner, the director, there will be an inspection of the Cancer Institute and of the Amsterdam zoo and aquarium, each of which are amongst the most celebrated in the world. The visitors to Amsterdam will be accompanied by Dr. J. A. Klauwers, the District Veterinary Inspector, who is responsible for the carrying out of the law concerning the contagious diseases of animals in Amsterdam and the surrounding district.

THE British Institute of Philosophical Studies, which was formed in the early spring of this year, has recently issued a syllabus of the initial courses of lectures to be given under the auspices of the Institute. The lectures, which are ultimately intended to cover every branch of philosophy, are open to all persons interested in the subject who have registered and paid the necessary fees, 1*l.* 5*s.* for a term's lectures, and 2*l.* 2*s.* for the whole course of two terms. The courses of lectures announced for the forthcoming term are on "Problems of Philosophy," by the Hon. Bertrand Russell, on Wednesdays at 5.30, at the London School of Economics, beginning October 7; on "Present Tendencies in Political Theory," by Mr. H. J. Laski, on Thursdays at 5.30, at the Royal Anthropological Institute, 52 Upper Bedford Place, beginning October 8; and on "Psychology," especially tendencies and controversies in modern psychology, by Prof. T. H. Pear, on Fridays at 5.30, also at the Royal Anthropological Institute. Copies of the

syllabus, which contains further announcements for the Lent term, can be obtained from the director of the Institute at 88 Kingsway, W.C.2, to whom all inquiries relating to the work of the Institute should be addressed.

THE centenary of the opening of the Stockton and Darlington Railway occurred on September 27, and to commemorate this important event a special exhibition has been formed in the Science Museum, South Kensington, as a supplement to the general railway groups of the land transport collection. This supplementary collection comprises many objects from this collection relating to the Stockton and Darlington Railway, together with a number of new objects, documents and pictures, bearing on the history of railways, which have been lent for the occasion by the railway companies and by private contributors. A catalogue of the collection has been prepared, the contents being classified under the headings—history, construction, locomotives, rolling-stock and working. The earliest books and other documents relating to the Stockton and Darlington Railway are shown, including George Stephenson's original report of 1822, and many original letters, portraits, prints and medals are exhibited in the historical section, besides early railway plans and specifications, drawings of works of construction and buildings, and examples of permanent way. A few models and numerous drawings of locomotives are also included, with various items connected with rolling-stock. Railway working is illustrated by signals and signalling apparatus, time-tables, tickets and ticket printing machines. The exhibition, which will be found on the ground floor of the new Science Museum building, will remain for several weeks.

IN consequence of the rearrangement of the collections in the different museums at Hull, as a result of the opening of the New Commercial Museum, one of the galleries in the Natural History Museum, Albion Street, has been entirely rearranged and devoted to the exhibition of osteological preparations, including a representative series of skeletons and skulls of various mammals and birds, the larger mammalia (whales, etc.) and fishes being exhibited in the Museum of Fisheries and Shipping in another part of the town. One side of the new gallery is devoted to human skeletons of various ages, and include bronze age, iron age, Roman, Anglo-Saxon and medieval skulls, the Museum possessing a remarkably fine series in this respect. There are also human crania from various parts of the world and plaster casts of all the really important prehistoric skulls at present available. In addition, there are copies of the well-known series of restorations of different types of prehistoric man, the originals of which are in the Museum of Natural History, New York.

A MESSAGE from the Dublin correspondent of the *Times*, which appeared in the issue of September 23, announced the appointment of Dr. Walther Bremer as Keeper of Irish Antiquities in the National Museum at Dublin. This appointment has been vacant since the resignation of the late Mr. E. C. R. Armstrong at the end of 1922 under the arrangements for the retirement

of Civil Servants made by the Irish Government. Dr Bremer is honorary professor of prehistoric archaeology in the University of Marburg, Germany, and has a high reputation on the continent as a prehistoric archaeologist, especially in connexion with the neolithic period and with the antiquities of Great Britain and Ireland. He has contributed a number of articles to the "Reallexicon der Vorgeschichte," published by Messrs. Gruyter, of Berlin. During the War he was a prisoner in England, but was released on parole and devoted himself to archaeological research.

DR G. C. CLAYTON, M.P., and Prof. H. C. H. Carpenter, F.R.S., have been appointed, by Order of Council dated September 16, to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

IN honour of the founder of the British Science Guild, Sir Norman Lockyer, the Council has established an annual Norman Lockyer Lecture, one of the objects of which is to direct the attention of the public to the influence of science upon human progress. The first lecture will be given by Sir Oliver Lodge, on Monday, November 16, 1925, at 4 P.M., upon the subject of "The Link between Matter and Matter." Lord Askwith, president of the Guild, will be in the chair, and the lecture will be delivered in the hall of the Goldsmiths' Company (by kind permission of the Master and Court of Assistants of the Company). Tickets of admission may be obtained on application to the secretary, British Science Guild, 6 John Street, Adelphi, London, W.C.2.

DURING the forthcoming winter, Mr. H. V. Garner, the guide demonstrator of the Rothamsted Experimental Station, Harpenden, will be able to give a few lectures to Chambers of Agriculture and Horticulture, Farmers' Clubs, Farm Workers' Associations, Agricultural Societies, etc., on the Rothamsted experiments in regard to artificial manures and their use on the farm, practical lessons from recent field experiments, profitable improvement of grass land, chalking and liming, and similar subjects. For students' societies and similar bodies, lectures can be arranged dealing with the planning and carrying out of field experiments, factors in soil fertility, etc. No fee will be charged for Mr. Garner's services, but any association engaging him would be expected to defray his travelling expenses and to make such

arrangements for the lecture as may be necessary. All communications regarding lectures should be addressed to the Secretary, Rothamsted Experimental Station, Harpenden.

SIR CHARLES SHERRINGTON, president of the Royal Society, will give the introductory address at the opening of the London (Royal Free Hospital) School of Medicine for Women (University of London), on Thursday, October 1, at 3 P.M.

THE new price list of fine organic chemicals issued in August by the British Dyestuffs Corporation, Ltd., includes indicators, microscopic stains, medicinal and photographic chemicals. Of special interest is the wide range of microscopic stains, produced by standardised methods and tested for purity both in the laboratories of the Corporation and independently. Information on a number of the substances can be obtained from separate booklets issued by the Corporation.

THE Oxford University Press announces the early publication of "The Surface History of the Earth," by Prof. J. Joly. The work is intended for the general reader with scientific interests and for students of geography and geology, and deals with the forces which have moulded the earth's crust.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned. In the Royal Aircraft Establishment, South Farnborough, Hants—A scientific assistant primarily for work in the aerodynamic section; two junior scientific assistants, one primarily for mathematical and experimental work on the stability and control of aeroplanes, and one for wind tunnel experiments, and three junior scientific assistants, respectively primarily for elasticity research, for problems arising in connexion with high altitude flying, and for work in connexion with indicating and recording instruments and similar apparatus—The Superintendent (October 13). A scientific assistant primarily for research in connexion with electrical ignition appliances—The Superintendent (October 20). A lecturer in chemistry at Armstrong College, Newcastle-upon-Tyne—The Registrar (October 17). A director and curator of the Harris Art Gallery and Museum, Preston—The Town Clerk, Town Hall, Preston (October 31). A research chemist at the new central research laboratory of the Colonial Sugar Refining Company, Sydney—Parbury, Henty and Co., 20 Eastcheap, E.C.3.

Our Astronomical Column.

BROOKS' PERIODIC COMET—As other observers failed to find any comet close to the place announced by Prof. Tcherny, fears were expressed that the news of the detection of Brooks' comet might be erroneous. A further telegram from Russia, transmitted by the I. A. U. Bureau, Copenhagen, makes it clear that the discovery is correct, but that Tcherny's first telegram gave incorrect position and magnitude. The following two positions are communicated:

	Univ. T.	R.A.	S. Decl.	Mag.
1925 Sept.	9 ^d 19 ^h 33 ^m 12 ^s	23 ^h 23 ^m 12 ^s	1° 49' 31"	13.1
	24 18 57.9	23 18 6.7	4 2 54	12.5

The observers are MM. Albitsky and Shain. These observations indicate that Dubiago's predicted date

of perihelion needs a correction very close to -6 days, his other elements being near the truth.

The following ephemeris for α has been deduced on this assumption.

	" R.A.	S. Decl.	log r	log Δ
Oct. 2.	23 ^h 16 ^m 19 ^s	4° 57'	0.278	9.965
10	23 15 39	5 48	0.276	9.977
18	23 16 35	6 25	0.274	9.993
26	23 19 22	6 46	0.273	0.013

The comet should be observable for some months. It is the fourth periodic comet observed this year, the others being Tempel (2), Wolf, and Borrelly. Faye's and Schorr's comets have also been looked for, but unsuccessfully as yet.

Research Items.

A SURVIVAL OF THE "THAMES PICK."—*Man* for September contains a note by Mrs. M. E. Cunnington on a "Thames Pick" found on a ledge or shelf in the chalk side of a pit-dwelling in Casterley Camp, Wilts. The flint is of a pale bluish-grey, the unground sharp nose shows no sign of use, and the whole surface is sharp and rough to the touch as if newly made, as it must have been when buried in the pit. The "Thames Pick" type of implement is usually held to be of late palæolithic or early neolithic date. In the present instance, however, it is recorded that it was found with three skeletons, two adult and one of a child, and under one of these were the remains of an iron brooch with a spiral spring of La Tène type, and under the child's skeleton was a second fragment of iron which was possibly the bow of another brooch. Pottery of a poor quality was also found which, taken in conjunction with the flint implement, might have led to an attribution to the Neolithic Age had it not been for the presence of iron. It is, however, clear from this find that implements of this type continued to be manufactured in Britain until well into the Iron Age.

PHYSICAL ANTHROPOLOGY OF THE HOS OF KOLHAN.—Mr. D. N. Majumdar has recently published several studies of the Hos or Kols and their culture. Of four in the current issue of the *Journal and Proceedings of the Asiatic Society of Bengal* (Vol. xx, N.S., Pt. 5) one deals with their physical characters, as shown in 10 measurements of 200 individuals which are given in a series of tables. They are short of stature, of dark complexion, with short, broad, and flat noses, small dark eyes, wavy to curly hair, beard or moustache being absent. The complexion varies from sooty black to dark brown. Fair Hos are occasionally encountered, but this is to be attributed to admixture with Rajput traders. The lips are medium, and slight prognathism is noticeable. The average cephalic index is 75.5, but 63 per cent. were dolichocephalic, 47 per cent. mesocephalic, and 12 per cent. brachycephalic. Cases of artificial deformation were noted. The highest nasal index was 91.1, the lowest 74.6. The average stature is about 161 cm., the lowest individual measurement being 158.2 cm., and the highest 170 cm. The arm's reach is proportionate to the stature, ranging from 166.6 cm. to 173.5 cm. Tattooing, formerly practised, has fallen out of favour, but where in use it is only on the fore-limbs, and especially the right hand. If a woman does not tattoo she commits a sin, as she takes nothing to the next world but these marks on her limbs.

THE BOSKOP SKULL.—Mr. W. P. Pycraft, who undertook to examine and report on the calvaria found at Boskop, Transvaal, in 1913, has contributed to the *Journal of the Royal Anthropological Institute*, Vol. LV., Part 1, a discussion of the conclusions at which he himself and Dr. H. S. Haughton, assistant director of the South African Museum, have arrived. Mr. Pycraft's reconstruction gives length 205 mm., breadth 150 mm., auricular height 125 mm., basibregmatic height 137 mm., cranial capacity probably 1717 c.c. In all its salient features the skull shows a likeness to the Bushman skull, but it is also comparable with the "Strandlooper" and the Cromagnon. The contours of the Strandlooper and Boskop skulls are almost identical except in the greater height of the latter. The Strandlooper stands midway between the Boskop and the Bushman skulls. Boskop Man is also genetically related to Cromagnon Man, the conclusion being that he would appear to be a derivative of Cromagnon Man and the progenitor of the

Bushman. It is therefore suggested that the proto-Bushman, *i.e.* the Boskop Man, arose out of the Neanthropic flux which gave rise to the Grimaldi people and the Cromagnards, the Australo-Dravidians and Rhodesian Man, the common stock from which all were derived being the smooth and "beetle-browed" Palæanthropic peoples. The apparently somewhat sudden appearance of the Neanthropic peoples is probably fictitious.

THE FLOODS OF THE NEVA.—The tendency of the lower Neva to inundate part of Leningrad has been a serious problem since the foundation of the town. It has been explained by river flooding due to precipitation, banking of the river flow by winds, and changes in the level of Lake Ladoga. In an article entitled "Les Crues de l'embouchure de la Neva" in *Matériaux pour l'étude des calamités* for April-June 1925, Dr. E. P. Pouichet shows that the main cause is a southerly and south-westerly gale in the southern part of the Baltic. This forces the water into the Gulf of Finland, especially since the free passage into the Gulf of Bothnia is obstructed by the Åbo and Åland archipelagoes. In the narrow and shallow Gulf of Finland the waters are heaped up, if the westerly winds persist, and overflow the tidal reaches of the Neva. If the westerly winds give way to northerly or north-westerly winds, the floods rapidly subside, and indeed may not reach dangerous proportions. Dr. Pouichet gives synoptic charts showing the meteorological conditions on the occasion of several serious floods, and describes the system of warning instituted some years ago and improved by the existing government in Russia. He discusses the possibility of protective works, but concludes that their cost would be prohibitive.

RAIN AS A CAUSE OF SPOTTING OF FOLIAGE.—Field observations having led to the conclusion that spotting of the foliage in apple trees in the wet season of 1924 was associated with the abnormal rainfall, Messrs. C. E. T. Mann and T. Wallace, of the Horticultural Research Station at Long Ashton, proceeded to examine the effect upon the foliage of these trees of temporary immersion in distilled water. As somewhat similar blotches appeared on these leaves, and as analysis showed that the distilled water was leaching considerable quantities of potash out of the leaves, the experiments were continued and showed that a variety susceptible to this spotting in the field, Cox's Orange, lost no less than 64 per cent. of the total potassium in the leaves after 24 hours' immersion in the water, whilst a variety resistant to spotting in the field in a similar experiment lost only 12 per cent. in the 24 hours. In view of their experimental results with varieties of different susceptibility, as recorded in the *Journal of Pomology*, vol. iv, pp. 146-161, there seems little doubt that the conclusion drawn from the field observations was justified, that rain was responsible for the spotting of the leaves noted in this particular season. It would also seem that the action of the rain water is associated with this little suspected capacity it has for leaching considerable quantities of soluble substances, including potassium compounds, out of the foliage of the plant.

CREAMING OF SPRAY FLUIDS.—Rowland Marcus Woodman continues his investigation of the fundamental physics and chemistry of spray fluids in the *Journal of Pomology and Horticultural Science*, vol. iv, pp. 184-195, with an interesting discussion of the difference between the "cracking" of an emulsion,

i.e. a mass separation of the two liquid phases, and the "creaming," in which a stable emulsion, containing practically the theoretical amount of the disperse phase when present in spherical droplets packed as closely as possible, separates itself by creaming from the excess of the continuous, and in this case denser, solvent phase. He points out that cracking and creaming are very different and that they are not necessarily favoured by the same conditions; furthermore, in practice with spray fluids, the danger is creaming. As a result of creaming a paraffin wash may be pumped on to foliage, the bulk of which is too dilute to be effective, whilst the remainder, the cream, may be so concentrated as to do damage. Mr. Woodman discusses the factors that facilitate creaming; he shows that the farmer is justified in his traditional view that a wide pan favours rapid creaming, a fact which is to the disadvantage of the sprayer, whose concoction is usually mixed in wide tubs on the farm. The author analyses the methods available to retard creaming, and gives his reasons for selecting as the most practical that of bringing both liquid phases nearer to the same density. He describes some very successful results obtained by means of cresols added to paraffin oil emulsions with this end in view. Altogether this paper seems a very satisfactory example of pure science in the service of horticulture. Mr. Woodman is working at the Horticultural Research Station, University of Cambridge.

PLIOCENE CLIMATE OF NORTHERN EUROPE.—Some deductions regarding the climatic conditions of Pliocene times in Iceland have been drawn by Gudmundur G. Bárðarson from his study of the mollusca in the deposits of that age, estimated at about 700 metres in depth, at Tjornes (*Det Kgl. Danske Videnskab. Selskab., Biolog. Medd.*, 4, 5, 1925). He finds that the remains of mollusca associated with warm-temperate seas occur chiefly in the older shell-bearing zones. These suggest climatic conditions similar to those of south and west Norway, or possibly of the British Isles. But during the period of the accumulation of the Pliocene deposits there was a gradual deterioration in temperature, for the southern forms of mollusca give place in the upper beds to an immigrant northern or arctic fauna, closely related to the molluscan fauna now existing on the shores of the North Atlantic. The Icelandic forms show, as geographical proximity would suggest, a closer relationship to the present-day fauna of America than do the fossils of the English Crag series, which the author considers to have been formed about the same time. There is no indication in the Tjornes beds of a sea-temperature on the coasts of Iceland colder than that of the present day.

PHYSIOGRAPHY OF THE SHIRÉ VALLEY—A paper on the physiography of the Shiré valley by Dr. F. Dixey has been published by the geological survey department of Nyasaland. Dr. Dixey shows that an examination of the uplands bordering the Shiré Rift exhibit several additional branches of the main rift of considerable importance. Parallel with the Upper Shiré Rift, which runs N.N.E., is the long depression that includes the Upper Lujenda, Lake Chilwa, and the plains to the south. Parallel with the Lower Shiré Rift, which runs N.N.W., is a depression that extends from the southern end of Lake Nyasa, and includes Lake Malombe, part of the Upper Shiré Rift, Lake Chilwa, and the eastern foot of the Mlanje mountains. These intersecting rifts thus account for the position of Lakes Chilwa and Malombe and the upland area of the Shiré highlands. Dr. Dixey discusses the succession of the faulting that caused these features, which he believes took

place at several distinct periods separated by appreciable intervals.

CLIMATE OF GLASGOW.—The Meteorological Office, Air Ministry, has published in Geophysical Memoirs, No. 23, a memoir on "The Climatology of Glasgow," by Prof. L. Becker, professor of astronomy in the University of Glasgow (M.O. 254 C., H.M. Stationery Office, 1925, 10s net). Weather observations recorded at the Glasgow University Observatory since 1843 are dealt with; since 1868 the observations have been taken in association with the Meteorological Office. In the course of time much building has sprung up round the Observatory, and it seems quite possible that some of the weather changes may be due to artificial causes rather than to natural change of climate. The author attributes the lines followed in the discussion as "suggested by inquiries from engineers and lawyers." The charm of the work is the diversity of inquiry to which the several elements are subjected. The statistics are said to have been ready for publication since 1908, when forty years were available, but funds for publication were lacking. Barometric pressure, temperature, humidity, sunshine, cloud, visibility, and wind are analysed, and to take temperature as an illustration, the examination consists of more than twenty tables. In addition to the normals for the several months and years, the diurnal changes and 5-day means, there are tables of excesses and deficiencies in mean temperature relative to the average, number of warm days and warm nights in summer, number of cold days and cold nights in winter (these are given for each year), number of periods of warm weather in summer and cold in winter. An examination of the discussion has suggested the wish that it might be possible to submit the Greenwich Observatory records to similar diversities of inquiry. There the system and uniformity of observation, together with the relatively open position, would probably allow a change if ascertained to be attributed to cosmical effects.

MAGNETIC DECLINATION AND THE MAGNETISATION OF ANCIENT LAVA.—The lava flows of Mount Etna have been studied by M. R. Chevallier, who shows that it is possible to determine the magnetic declination at the time the lava solidified by observing the direction in which it is now magnetised (*Annales de Physique*, July-August). Although the actual field in which solidification took place was, in general, disturbed by the presence of other masses of magnetised lava, it appeared possible, by taking the mean between the directions obtained from a number of specimens chosen from points in a given lava flow where there has evidently been no displacement of the lava after solidification, to obtain a satisfactory value for the declination at the time of solidification. The values deduced in this way from the lava streams of 1669 and 1911 agree with the known declination curve; and when the declination values determined from observations on earlier lava flows of known date were plotted, it was found that a curve was obtained which continued the known curve symmetrically backward, passing through zero about 1630, through 18° E. about 1440, and again through zero towards westerly declinations about 1240. The time intervals from zero to zero are nearly equal, and the amplitudes of the easterly and westerly declination are the same. The curve of dip shows irregularities which are attributed to the influence of adjacent lava masses.

ATMOSPHERIC IONISATION.—In 1910 and 1911, by observation of the ionisation of the atmosphere at different heights, Gockel came to the conclusion that the radiations due to the radioactive processes taking

place in the earth's crust and in the lower atmosphere were not capable of explaining the conductivity of the upper atmosphere, and suggested that penetrating γ -radiations entered the atmosphere from outside. Since then a large amount of work on the subject has been done, which is summarised and discussed by Dr. Walter Schulze in the *Naturwissenschaftliche Umschau* for July. He comes to the conclusion that the existence of such a hard γ -radiation has been established, and that it originates either in the upper atmosphere itself, or more likely in the neighbourhood of the Milky Way.

QUARTZ FILTERS.—The *Chemiker-Zeitung* for August 25, p. 716, gives an account of some experimental tests on quartz crucibles with filtering bottoms made by the Jena firm of Schott und Gen. The porous bottoms are made from the same material as the crucibles themselves, and in the case of those made from rock-crystal the analytical results were highly satisfactory, even when normal solutions of ammonia or caustic alkalis were used for washing the precipitates. The speed of filtration is rather slower than with the ordinary asbestos pads in Gooch crucibles. The analytical results obtained with the opaque crucibles were not quite so good, but the latter are suitable for filtering very hot liquids.

HIGH FREQUENCY VIBRATIONS IN PIEZOELECTRIC CRYSTALS.—A new method for showing the vibrations produced in piezoelectric crystals by an alternating electric field is described by Messrs. E. Giebe and A. Scheibe in the *Zeitschrift für Physik* of August 8. A suitably cut rod of quartz, the length of which was either 100 or 80 mm., the breadth 3 mm., and the thickness 1.5 mm., was in the simplest case placed between two electrodes connected to an oscillating valve which could be tuned to different frequencies. One of the electrodes, E_2 , was separated from the quartz rod by about 0.5 mm., and it was found that, when the bulb containing the electrodes was evacuated, a discharge took place in the space between E_2 and the quartz rod when the frequency had a certain very definite value, which corresponded to a longitudinal vibration of the rod with a node at the centre. The luminosity was greatest at the centre. W. G. Cady showed in 1922 that a crystal rod was set into longitudinal vibration in a suitable alternating field in virtue of the reciprocal piezoelectric effect, and in the present experiments these vibrations produce in the crystal alternating positive and negative surface charges which depend on the alternating compressions and rarefactions, and are therefore greatest at the node; these charges alter the electric field and facilitate the electric discharge. It is possible by means of a suitable system of electrodes to obtain a similar effect for an upper harmonic of the fundamental vibration of the rod, and photographs are given showing the appearance of the discharges for a number of upper harmonics up to the fifteenth.

THE PRODUCTION OF HELIUM IN GERMANY.—Since there are no natural gas sources from which helium can be obtained in Germany, experiments are being carried out at the Physikalisch-Technische Reichsanstalt in Berlin on the production of helium by other methods. An account is given in *Die Naturwissenschaften* (1925, p. 695) of the isolation of the gas by Dr. Walther Meissner by liquefaction from the helium-neon mixture, which is a by-product of the Linde Oxygen works. The Linde process is applied, liquid air and liquid hydrogen being used as refrigerators. It is claimed that the method is simpler than those used by Prof. Kamerlingh Onnes in Leyden and by Prof. McLennan in Canada. A second method described by Kurt Peters (*ibid.* p. 746) is by

heating monazite sand, containing 5 to 7 per cent of thorium, to 1000° C. One litre of helium was obtained thus from 1 kilogram of the sand. It is pointed out that the German thorium factories, which produce 60 tons of thorium nitrate annually from 500 tons of monazite sand, could recover between 250 and 500 cubic metres of helium.

NITROGEN FIXATION.—An interesting illustrated account of the synthetic ammonia processes of Casale and of Fauser is printed in *La Nature* of August 22. Both these processes are now in use on the manufacturing scale. The Casale process is more or less identical in principle with the well-known Haber process, but the details of working are different. Hydrogen is generated in the pure state by electrolysis of water; the nitrogen is obtained by mixing air and hydrogen in such proportions that on ignition all the atmospheric oxygen is removed as water, leaving nitrogen and hydrogen in the correct proportions for combination. The dried gas mixture is pumped through a heat recuperator and thence into the catalyst furnace. This consists of four concentric tubes. The electric heating element is placed in the centre tube; the next annular space is packed with catalyst (an active form of iron). The two outer annular spaces act as a heat exchanger. The gas mixture passes through the outer annular space (which is heated by hot gases from the catalyst chamber passing through the next space) and thence over the heating element in the centre tube. They pass from this to the next tube, containing the catalyst, and then into the third annular space, from which they are drawn off. This furnace economises heat. The exit gases pass once more through the heat recuperator and then to a refrigerator where liquid ammonia is condensed out. This economical process is now being worked at Terni and Nera Montoro (Italy), at Toulouse, in Belgium, Japan, France, Spain, Switzerland, and United States. In the Fauser process hydrogen is prepared electrolytically, mixed with nitrogen (see below) and compressed to 300 atm. During the compression a small quantity of water is added, which serves both as lubricant and to absorb the ammonia. The mixture is passed over the catalyst and then proceeds to the absorber. The aqueous ammonia solution thus obtained is distilled, the vapours being collected in a gasometer. The ammonia is then oxidised to nitric acid by mixing with air and passing over heated platinum. The excess nitrogen from the air, which proceeds from this apparatus, is used to mix with the hydrogen in the synthetic plant. The process is in use at Novara, Marengo, and other Italian towns.

MODERN LOCOMOTIVES.—The August issue of *La Science Moderne* has a well-illustrated article of 14 pages on the modern locomotive by M. Leftot, of the testing department of the Orleans Railway. The modern locomotive is the same in type as the one of 1845, and has now reached a stage in its development when increases of power or efficiency are only likely to be brought about by radical changes in construction or working. The present weight of European locomotives is about 12 tons, the steam pressure between 200 and 300 lb. on the square inch, and the power 2000 H.P. Oil fuel has been tried, but the increase of the price of oil has retarded progress in this direction. Powdered coal produced immediately before use in the furnace has been used successfully in America. Compounding and superheating are customary on some lines. The author considers that the future lies with the steam turbine and the heavy oil motor, and gives some details of European locomotives constructed on these lines.

Experimental Zoology in Poland.

WE have recently received several volumes of the Bulletin International de l'Académie Polonaise des Sciences et des Lettres covering the period June 1922-May 1924. The following notes based on communications in the Bulletins will serve to indicate some of the activities of workers in Poland in the field of experimental zoology during this period.

In "L'hérédité dans les cellules végétatives au cours de la régénération chez l'axolotl" (Bulletin, June 1922) Godlewski records his endeavours to discover whether somatic cells as distinct from genital cells preserve their inborn characters when transported to a new environment, or whether in such circumstances they "acquire" new characters. He transplanted a small piece of the skin of a black axolotl to a previously prepared spot on the base of the tail of an albino axolotl from which he had removed the skin. The new graft effected a satisfactory union with the neighbouring tissues and the animal was kept alive for five years. After the graft had united with the neighbouring skin, the tail was removed by a cut passing through the graft, and in about six months a new tail had been completely regenerated.

It is obvious that the grafted skin would necessarily take part in forming the new skin covering the regenerated tail, and the question was whether the new cells produced from the black skin would remain black or not. It was found that as the tail grew a black band of skin extended from the graft towards the tip of the tail, but that as time went on this band became narrower, and finally, after about two years, completely disappeared; but the area covered by the original graft maintained its black colour. Hence Godlewski concludes that the new cells derived by division from the black cells of the graft retain for a time their "inborn" black character, but that as time goes on their descendants slowly "acquire" the albino character of their environment and transmit this new character to their later descendants.

The original graft alters its position somewhat and moves slowly towards the base of the tail, but does not achieve more than a moderate change of position. This puzzling fact Godlewski explains by the assumption that in regeneration the skin grows more quickly than the other tissues, and so glides over them towards the tip of the tail.

Godlewski obtained a different result when he grafted a piece of skin from an albino axolotl on a wound in the base of the tail of a black axolotl. In this case the grafted piece of white skin soon assumed the colour of its black surroundings. This is explained by assuming that the skin chromatophores from the surrounding black skin migrate into the graft and change its colour.

Z. Kolodziejski has a paper on "Studies on the Metabolism of the Budding Hydra" in the Bulletin for October 16, 1923. In some cases of budding, as for example in Annelida, it has been shown that physiological differentiation is subsequent to morphological differentiation. Thus the reaction of the front part of the gut of an Annelid is acid whilst that of the remainder is basic, but the whole alimentary canal of the bud is basic in its reaction until its development is complete, and then alone physiological differentiation sets in. The primary object of the author was to discover whether similar differences in capacity existed between the mother Hydra and its immature buds.

The bud of Hydra is not formed as a simple eversion of the body-layers of the mother. It originates as a local thickening of the interstitial cells of the ectoderm, which penetrate between the neighbouring ectoderm

cells and, after having pierced the supporting lamella, between the endoderm cells also. These young cells gradually become transformed into ordinary ectoderm and endoderm cells, and the mass becomes hollowed out and forms a young bud.

When Hydra is fed on food coloured with Sudan red or on naturally coloured food such as green infusoria, the fate of the food can be followed. The author in this way confirms previous accounts to the effect that the food is first partially dissolved and converted into an emulsion with solid particles by the action of ferments secreted by special gland cells. Thus the contents of insect larvæ provided with hard chitinous coverings such as those of Chironomus or Corethra are dissolved out. The particles are afterwards ingested by amoeboid action on the part of the large endoderm cells. The use of colour indicators proves that the endoderm cells have a basic reaction. All the endoderm cells both of mother and bud are equally active, and the particles of the food emulsion penetrate even into the tentacles, especially into those of the bud, which have wider internal openings than those of the mother.

When a brown Hydra is fed on the green infusorian Euglena, the chlorophyll is ingested by the endoderm cells and the animal appears like a green Hydra; but the chlorophyll is finally completely digested and disappears. Hydra can be induced to ingest fat by mixing it with protein; the fat globules afterwards appear in the endoderm cells but are very slowly dissolved. Starch is at once rejected as indigestible material. The brown granules of the ordinary Hydra, which give to it its characteristic colour, are of an excretory nature. They have a crystalline character which is revealed when they are examined by polarised light. They are not influenced by alcohol, ether, or chloroform, but yield slowly to the action of 10 per cent solutions of caustic potash and soda, and of hydrochloric, nitric, and sulphuric acids. The author considers that they are probably allied to guanin. After solution the colour remains as an amorphous mass, and is to be looked upon as another substance which is being excreted along with the supposed guanin.

S. Skouron in "Le Rapport plasmo-nucléaire pendant la Spermatogenèse chez *Helix pomatia*" (Bulletin, May 1924) examines the question whether there might be an emission of nuclear substance into the spermatogonia of Helix. He preserved the ovo-testes in corrosive sublimate and acetic, and determined by comparison with living material that this preservation produced no change in the nucleo-plasmic relation.

The youngest spermatogonia had large vesicular nuclei with a very fine spireme of chromatin. As the cell grows this spireme thickens and becomes contracted into a closely woven tangle of chromatin at one side of the nucleus. This stage is of course that of "synapsis." Afterwards the tangle loosens, distinct chromosomes appear, and the nucleus and cell divide into two. The later generations of spermatogonia are distinguished by their larger size, and by the fact that even in the resting nucleus the chromatin can be seen as thickenings of the nuclear network. There is always a "yolk-nucleus" or "Nebenkern" in the protoplasm at the side of the nucleus. The period of growth is terminated by the formation of the spermatocytes of the first order, distinguished by their comparatively large size and by the arrangement of the chromatin material in tetrads. The spermatocytes, by the reducing or meiotic division, become spermatocytes of the second order; by another division following immediately on this, each

spermatocyte forms two spermatids. These are much smaller cells with nuclei filled with large and small granulations of chromatin. The spermatids by a series of well-known changes are converted into the spermatozoa.

The proportion of plasma to nucleus in young spermatogonia is about 2.3-1; but in spermatogonia in which synapsis has set in, it varies from 1-1 (equality) to 0.7-1. These figures indicate an enormous growth of nuclear matter which can actually exceed in bulk the remaining plasma. But if we follow the proportion between protoplasm and nucleus in subsequent generations of spermatogonia, we find that this in the first succeeding generations rises to 2.5-1 and in the later generations increases to 5.3-1. As the latest generations of spermatogonia are changed into spermatocytes of the first order, this proportion rises to 6.8-1. After the formation of the spermatids, and during the growth of these, the proportion rises to 19-1.

In the spermatogenesis of *Helix* there often occur polynuclear cells each of which gives rise to several spermatozoa. These cells result simply from nuclear division unaccompanied by cell division. If we compare the relation of protoplasm to nucleus in these cells we find that it runs through a series of changes parallel to those undergone by the plasmo-nuclear relation in normal spermatogonia. During the whole period of development of the sperm cells there is never any evidence of the emission of chromatinic substances from the nucleus into the protoplasm such as occurs in the egg.

Jean Prüffer contributes an interesting paper on "Observations and Experiments on the Phenomena of the Sexual Life of *Lymantria dispar*" (Bulletin, January 8, 1923). The pairing impulse becomes active as soon as the imago of the Gypsy-moth emerge from their cocoons, and since a large number of chrysalides are found on the trunk of the same tree and the males emerge first, the latest males to emerge fertilise the first females. But a great deal of pairing occurs during the subsequent lives of the insects; and to accomplish it the males fly long distances, their flights occurring only by day. The females, though inactive by day, fly about at night.

Experiments proved that the males were able to seek and find the females, when their eyes were covered with an opaque substance, when their wings were removed, when one entire antenna was removed, and when the distal portions of both antennæ were removed. When both antennæ, however, were entirely removed, the males were unable to find the females even when their eyes were uncovered. It is obvious, therefore, that the sense organs which serve to detect the female must be situated in the basal portion of the antenna, and we may remember that it was in this region that Mr. K. M. Smith, of the Imperial College of Science, now at the University of Manchester, discovered and described highly developed sensory pits in flies.

The attractiveness of the female for the male was not diminished by the removal of the "scales" from the female's wings, nor by the removal of its wings, nor by the amputation of the two antennæ; but it was diminished and rendered uncertain by the removal of the scales from the abdomen, and entirely destroyed by the amputation of the abdomen. On the other hand, the amputated but otherwise uninjured abdomens of females were as attractive as the uninjured insects. It is obvious, therefore, that the hedonic scent which emanates from females and attracts males is localised in the abdomen and especially in the scales covering the genital region.

It has been shown that in newly hatched pigeons

the liver and pancreas increase rapidly in weight, and that their rate of increase is out of all proportion to the increase of weight in the animal. Nevertheless in sections, no signs of either mitotic or of amitotic division of cells is to be seen. In the full-grown animals the liver and pancreas decrease in weight. In order to investigate this matter further, young pigeons were killed on the first, third, and fifth days after hatching and thereafter on every second day until full size was attained. The liver and pancreas were weighed in each bird thus examined and portions of these organs fixed and sectioned. ("Cell Growth and Body Growth Investigations in Pigeons," by L. Kaufmann. Bulletin, April 1924.)

It transpires that the cell volume increases most rapidly between the first and third day (about 50 per cent). Between the third and fifth day the rate of growth decreases, and on the ninth day the cells are actually smaller, a proof that cell division has taken place. The nucleus undergoes its greatest growth during the first two days, but in seven-day old pigeons it is only as large as nuclei in one-day old pigeons, and in still older pigeons it is even smaller, so that from the ninth day there may be said to be a permanent shift of the nucleo-plasmic relation in favour of the plasma. In one-day old pigeons the plasma exceeds the nucleus in volume 12.4 times, but in the full-grown bird the volume of the plasma is 66 times greater than the nucleus. After the seventh day, the number of karyokinetic figures diminishes and the increase in volume of cells is roughly proportionate to the increase in weight of the whole organ. As the liver is a storage organ, its weight increases with feeding and diminishes during fasting more than does the weight of the body as a whole. The decrease in weight of the liver in old birds is associated with a diminution in cell plasma.

In the growth of the pancreas, similar phenomena were observed, but the following differences are to be noted. The liver cell of the adult has five times the volume of the liver cell of the one-day old bird, but the pancreas cell of the adult is only twice the volume of the corresponding cell in the one-day old bird. The highest curve of increasing weight in the pancreas corresponds to the lowest curve of increase in cell-volume, whereas in the liver the lower curve of increase in liver weight corresponds to the higher curve of cell growth.

The author concludes that the nucleo-plasmic ratio has not, as had been previously supposed, a fixed point of equilibrium for each species, but that with each change in the general physical condition the nucleo-plasmic area may undergo alteration. Further, increase in volume and weight may be due to increase in amount of deutoplasmic substances and not of plasma.

Since Urodela are probably the most primitive land vertebrates now surviving, the mode of development of their blood-vessels, as indeed of their other organs, becomes a matter of interest and importance. This development had previously not been satisfactorily traced back to a sufficiently early stage of development; former authors relied mainly on sections, but Z. Grodinski ("Über die Entwicklung der Gefässe des Dotterdarmes bei Urodelen," Bulletin, February 11, 1924) has made successful injections of exceedingly young larvæ beginning with those only 4.5 mm. long.

These "larvæ" are really embryos with the tail and head merely indicated. In this youngest stage the main blood-vessels arise as metamerically arranged transverse branches from the aorta which unite with one another on either side to form a longitudinal vein at the level of the ventral edges of the myotomes,

which the author terms the *vena mesenterica*. From this vena mesenterica, further transverse vessels arise running half-way round the yolky gut and uniting on each side in its ventro-lateral region to form another longitudinal vessel, which are termed the *vena omphalo-mesenterica*. In older larvæ (5.5 mm in length) these two omphalo-mesenteric veins unite to form a single median *sub-intestinal* vein, which loses itself in the liver in front, and behind is continuous with the caudal vein. The *venæ mesentericæ* open into this sub-intestinal vein in front.

When the larva has attained a length of 7 mm. the yolk begins to disappear rapidly and the gut consequently to shrink in diameter. The *vena mesenterica* of each side moves in a dorsal direction, and so approaches its fellow. The two become connected

by transverse anastomoses and finally fuse into one. This single vein in the region of the duodenum describes a loop and fuses with the sub-intestinal vein. The transverse branches connecting it with the sub-intestinal vein become transformed into a network enveloping the intestine. Those branches which connected it with the aorta disappear. The hinder end of the sub-intestinal vein now disappears, and finally only a small anterior portion of it remains where it receives the mesenteric vein. The posterior cardinal veins begin as vessels draining the developing pronephros on each side. These gradually extend backwards until they reach and unite with the caudal vein and drain off its blood, and it is this new connexion which leads to the disappearance of the sub-intestinal vein.

E. W. M.

The Source of the Cold Air of the North "Polar Front."¹

By Prof. W. H. HOBBS, University of Michigan.

DENUDED of its liquid envelope, the figure of the earth may be compared to that of a tomato having a flat lump affixed at one side of the depression from which the stem has been removed. Not a close parallel—even a caricature—but I trust a true one, and successful caricatures are full of meaning. It is necessary to place the tomato in such position that the depression represents the deep basin of the Arctic Ocean, the bulging portion which is opposite will then represent the flat ice-dome of the Antarctic continent, and the artificial lump beside the depression the entirely similar though somewhat smaller ice-covered continent of Greenland. Both of these domes rise to elevations of nearly two miles above sea.

No adequate treatment of the atmospheric circulation is possible unless account be taken of this unsymmetrical figure of the earth; though, curiously enough, it has been the rather general custom to discuss the circulation of the atmosphere as though the areas surrounding the two ends of the earth's axis were characterised by exactly similar conditions. The theory of Ferrel, and the newer conception of Bjerknes which seems to have taken its place, alike ignore the contrast which exists between the two polar regions.

Bjerknes, in reviving an older view of von Helmholtz, has assumed that because of exceptionally high irradiation about both poles of the earth there must be formed about them caps of cold air with corresponding areas of high pressure; and that this cold air must pour out in all directions and meet the warmer air from the equatorial regions upon a surface of discontinuity—the "polar front."

Of the existence of a source of cold air within high latitudes, and the families of cyclones associated with it which the Bjerknes, father and son, have made known in a series of brilliant monographs, it is impossible to doubt. The individual characteristics of the cyclones composing a family within which youthful characteristics and notably turbulence are found curiously reversed, the crescendo of vigour which they display in sequence, and the abruptness with which the series comes to an end—these discoveries must be accounted as very important contributions to meteorology.

It is the field to which Bjerknes's keen research has not been directly extended, but within which the chief foundation of his theory has been laid, toward which I now direct attention. Is the north polar region one of high atmospheric pressure from which cold air is poured outwards? Fortunately the data

for a satisfactory answer are present, and the decision must be in the negative.

We may perhaps conveniently limit the north polar region by the parallel of 80° N., which will bring within it the entire Arctic Ocean for the sectors facing Europe and eastern North America, and will include upon its margins relatively small portions only of the land masses which in part bound that ocean. So far as explored, and with little doubt throughout, this entire area is deep sea covered with floating ice-cakes, which are continually drifting and which in no case rise more than a few tens of feet above the surface of the sea.

During the years 1894-96 the *Fram* drifted far into this region, and for the entire calendar year 1895, when the ship was nearest the Pole, it zigzagged along the 85th parallel of latitude. The mean daily atmospheric pressure for this year based upon complete data was 761 mm., with very slight seasonal or monthly range of pressure. Mohn, who discussed the meteorological data on the basis of the entire drift,² wrote: "The pressure at the North Pole seems to have its maximum—about 764 mm.—in April, and minimum—759 mm.—from June to September. This gives an annual range of only 5 mm." As I have divided the cruise, for the calendar year 1894 during which the *Fram* zigzagged between latitudes 79° and 84° N., the mean annual pressure was 758 mm.; and for the seven months of 1896, which were about equally divided between winter and summer, during which the vessel ranged in position from lat 85° to 81° N., the corresponding figure was also 758 mm.

These essentially normal figures obtained for the mean annual atmospheric pressure of the north polar region are, moreover, confirmed by the observations made by other explorers within the region or very close to its border, as the following figures will show:

Place	Latitude	Explorer	Mean Annual Pressure
Cape Flora . . .	79° 77'	d'Abuzzi	mm.
" . . .	"	Fiala	760
" . . .	"	Jackson	753
Rudolph Island . .	81° 13'	Nansen	756
Teplitz Bay . . .	81° 27'	Fiala	757
Moser Bay . . .	79° 57'	A. E. Nordenskiöld	754
Advent Bay . . .	79° 9'	Wegener and Robitzsch	757
Fort Conger . . .	81° 40'	Nares (1875-76)	756
" . . .	"	Greely (1881-82)	759
" . . .	"	" (1882-83)	758
" . . .	"	Peary (1909-10)	759
Polaris Bay . . .	"	Hall (1871-72)	761
Cape Sheridan . .	82° 25'	Peary	761
			759

¹ Paper presented to Section E (Geography) of the British Association at Southampton on August 28.

² H. Mohn, The Norwegian North Polar Expedition, 1893-96, Scientific Results, edited by Fridtjof Nansen, vol. 6, London, 1905, Meteorology, p. 572.

There is here a quite monotonous uniformity, and the records for winter and summer months considered separately are similarly uniform, as the range in pressure is throughout very small and quite in harmony with the known characteristics of an expanse of frozen sea.

The one continuously high pressure area of large dimensions to be found within high—though not polar—latitudes of the northern hemisphere, is the continent of Greenland, with the geographical centre distant some nineteen degrees from the North Pole. Greenland is a flat dome of snow-covered ice rising nearly two miles above the sea and, thanks to Peary and a long line of distinguished Danish explorers, of which Lauge Koch is the latest, Greenland is far better known than is its sister ice-dome in the Antarctic. Summer and winter alike it is overlaid by a high pressure area, and the anticyclonic circulation is characterised by powerful pulsations, or *strophs*, which begin gradually, develop centrifugal surface winds in a mighty crescendo of vigour often culminating with hurricane intensity. This outward flow of cold air drops down off the ice-dome and comes to a sudden halt at the culmination of its intensity. With this abrupt termination are associated a sudden rise of temperature and all the other characteristics of falling winds—foehns. As a surface wind this air does not pass out beyond the coast of Greenland, and must in consequence rise in the passing cyclones of which the coast line is the common border with the anticyclone.³

The fixed anticyclone of Greenland and the corresponding one over the Antarctic must not be confused with migrating anticyclones, which they resemble only in the direction of rotation and vertical movement, and very little in their quantitative attributes. They are the great drainage shafts for the high level currents as well as reversing positions for the general atmospheric circulation—they are the wind poles of the earth.

Of the "polar front" Bjerknes says:⁴ "On the north side of this line all signs indicate air of polar origin; it has a low temperature for the latitude, shows great dryness, distinguishes itself by great visibility. . . ." Now these are not the characteristics of the air over the polar sea, where rain and fog are common, but just those of winds which drop down from a height, and such conditions are nowhere observed in such perfection as on the borders of Greenland. Moreover, the winds of the European sector of the north polar region are not outward toward Europe. They are extremely variable in direction, but winds of southerly component are somewhat more common than those of northerly component.

To bring out clearly the relationships of the strophic outpourings of cold air from the high continent of Greenland to the cyclone families of which J. Bjerknes has furnished so intimate a portrait, it will be necessary to state the salient characteristics of these interesting cyclones.

Each cyclone family is made up of sometimes two but generally four to six cyclones in succession, designated in order A, B, C, and D, with sometimes

E and even F, and these cyclones represent a crescendo of vigour. They usually pass eastward during a period of about six days and on paths which diverge from some point near to but west of the coast of north-western Europe. Cyclone A is weak and sluggish in its movement, travels slowly, and generally pursues a course over Norway to the Arctic. It seems to be in a dying condition, and this is interpreted to mean that it has travelled from some region far to the west of Europe. Cyclones B and C, starting from some point west of Europe but relatively near, swing to the right and pursue their way farther south so as to pass over Sweden and Finland. D cyclones either follow this route or steer still farther to the right over Denmark, southern Sweden, and the Baltic; whereas E cyclones, if they are formed, pass either along this latter route or still farther to the southward.⁵

Now with the exception of the first one or two members of a cyclone family, which Bjerknes and Solberg believe to have travelled a long distance, the remaining cyclones of the family are thought by them to have been generated relatively near to but west of north-western Europe.⁶ There is, I believe, confirmation of this near origin for all later members of the cyclone family in the fact that such families have not been recognisable in the United States,⁷ and there is much reason to believe that those cyclones which are passing Greenland at the times of outpouring of cold air (strophs) within the Greenland glacial anticyclone, are by it rejuvenated and have imparted to them a measure of vigour which is dependent upon the stage to which the stroph has evolved at the time. The crescendo of vigour, the sudden halt, and in a rough way the period covered, are all closely in correspondence between the stroph of the anticyclone and the cyclone family.

Enough has been said, it is believed, to bring out the intimate relationship which appears to exist between the cyclone families of western Europe and the glacial anticyclone of Greenland, also to show that the cyclones C to E of each family are probably rejuvenated as they pass the east coast of Greenland; and that the cold air supply of the "polar front," instead of coming from the north polar regions, is due to outpourings from the strophs of the Greenland anticyclone. If there is a surface of discontinuity between this cold air and the warmer air of equatorial origin, this so-called "polar front" should be known as the *Greenland front*.

The close correspondence in time of the arrival at the Greenland coast of foehn winds from the interior with the passage of strong cyclones along the coast, was long ago observed on the west coast by Rink⁸ and on the east coast by Holm⁹; and confirmation has been found in the work of later observers, notably Stade.¹⁰

To give warning of the coming of dangerous cyclones to the coast of Europe, Bjerknes has recommended that a meteorological station equipped with wireless be established on the southern point of Greenland. A better locality for such a station would be opposite the widest portion of the continent, but this station should be located upon the slopes of the ice-dome at an elevation of at least 3000 feet, since the outstreaming currents

³ W. H. Hobbs, *Zeitsch f. Gletscherk*, vol. 5, 1910, pp. 110-120. Proc. Am. Phil. Soc., vol. 49, 1910, pp. 99-104. "Characteristics of Existing Glaciers" (Macmillan, 1911), chaps. ix, xvi, and especially the Afterword. "The Role of the Glacial Anticyclone in the Air Circulation of the Globe," Proc. Am. Phil. Soc., vol. 54, 1915, pp. 185-225, figs. 11. "The Mechanics of the Glacial Anticyclone illustrated by Experiment," NATURE, July 22, 1920. "The Glacial Anticyclones, the Poles of the Atmospheric Circulation," monograph soon to be published in book form by the University of Michigan.

⁴ V. Bjerknes, "The Meteorology of the Temperate Zone and the General Atmospheric Circulation," NATURE, vol. 105, June 20, 1920, pp. 522-524.

⁵ V. Bjerknes, "The Importance of Wireless Weather Reports from Greenland," *Monthly Weather Review*, Washington, Jan. 1922, pp. 16-19.

⁶ J. Bjerknes and H. Solberg, "Life Cycle of Cyclones and the Polar Front Theory of Atmospheric Circulation," *Geofysiker Publikationer*, vol. 11, No. 1, 1922, p. 14.

⁷ See A. J. Henry, *Monthly Weather Review*, Sept. 1922, pp. 468-474.

⁸ H. Rink, "Grönland," 1860, pp. 111-112.

⁹ "Meddelelser om Grönland," vol. 9, 1889, pp. 348-408.

¹⁰ E. von Dryjalski, "Grönland-Expedition der Gesellschaft für Erdkunde," 1891-93, Berlin, 1897.

override in large measure the lower strata of air. The tumult of the tempest above is often heard in the fjord as a dull roar, though the surface of the water is not stirred by a ripple.¹¹ The projected Danish Greenland Expedition of 1926-27, which is to be commanded by Dr. Lauge Koch, will for the first time afford an opportunity to put this suggestion to a practical test, for his base is to be located on Scoresby Sound. On the border of the Antarctic ice-dome, Sir Douglas Mawson, equipped with wireless, was able in 1911-14 to show that the outrushes of cold air preceded by about forty-eight hours the arrival of strong cyclonic disturbances at the Australian south coast.¹² Some such prevision for north-western Europe should be possible from a station on the Greenland dome, or on high land outside reached by the strong slope winds.

¹¹ Cf. Rink, *op. cit.*

¹² D. Mawson, *Geogr. Journ.*, vol. 44, 1914, pp. 257-286

Transport Problems.

AT the Southampton meeting of the British Association, Section F (Economic Science and Statistics) joined with Section G (Engineering) for the discussion of transport problems. A two-days' joint meeting was held concurrently with the separate meetings of the respective sections.

On the first day the representatives of the engineers discussed the more technical aspects of the road problem. Col. H. T. Tudsbery, of the Ministry of Transport, read a paper on "The Economics of Highway Engineering," in which he dealt with traffic matters and the construction, maintenance and design of roads. Stressing the cost involved in traffic delays, he computed that one-third of a lorry's time in the London dock area is consumed by traffic delays.

Mr. Philip Johnson, speaking of the "Roadless Vehicle," indicated the great scope available to such vehicles in undeveloped countries where railways or roads would be too expensive to build. He suggested that in much less time than it has taken to develop road vehicles to the present stage, roadless vehicles will show a similar development. He believed that there can be little question about the demand for them, since that portion of the world which is well equipped with roads is an insignificant fraction of the areas where no efficient transport facilities exist at all.

The third paper, by Mr. W. Maughan, dealt with the classification of roads. He described some early road censuses of traffic that he had undertaken, and stressed the importance of accuracy in that work.

On the second day three papers were read by members of the Economic Section. Mr. Tetley Stephenson discussed the "Present Position of British Railways." Somewhat pessimistic in tone, he emphasised the effects of the competition of road transport. He alleged that in practice the road haulier had a subsidy, since part of the cost of road repair was borne by the local taxpayer. He advocated relief from such local taxation imposed on the railways. He referred also to the fact that the British trader demands a very high quality of service, expecting rapid delivery and no waiting for full loads—factors, of course, that tend to increase cost. The trader also demands and obtains a long period of free demurrage—an expensive form of warehousing to the railways. Emphasising the necessity of operating economies, Mr. Stephenson stated that, as the labour bill accounts for 65 per cent. of the expenses, economies must inevitably involve a material reduction in this item.

A paper on the "Economics of the Modern Port," by Mr. Alfred Schofield, outlined the development of the modern port. Two of the factors, he said, which

determine the economic importance of a port are the hinterland which it serves and the nature of the shipping that is cleared at it. A large port cannot, however, live on passenger traffic alone. Trade in Great Britain tends to concentrate in five or six leading ports, and the future lies with the large port.

The third paper was read by Mr. K. G. Fenelon, who took as his subject "The Development and Economic Significance of Road Transport." In the first part of his paper, which was mainly statistical, he illustrated and analysed the growth in the number of motor vehicles in Britain, from some 854,000 in May 1921 to some 1,420,000 in May 1925. In about the same period the increase in the U.S.A. was from some 9,200,000 to some 17½ million. The reasons for this great development are to be found in the economic advantages of road transport. Road transport is flexible, door-to-door services can be provided, and but a small capital outlay is required to purchase a vehicle. On the question of the economic significance of motor transport, Mr. Fenelon showed that it is opening up the country to an extent never before achieved, and that this has important bearings on social and industrial developments. Road transport is playing an important part in relation to agriculture and rural life, to housing and health, and to the further development of industrial technique.

University and Educational Intelligence.

NEWCASTLE.—Prof. H. V. A. Briscoe has been appointed director of the chemistry department of Armstrong College, Newcastle-upon-Tyne, in succession to Prof. W. N. Haworth, now professor of chemistry in the University of Birmingham. Prof. Briscoe has been for several years professor of inorganic and physical chemistry in Armstrong College. Dr. G. R. Clemon has been appointed professor of organic chemistry. He has recently been in charge of the research department of the British Dyestuffs Corporation at their laboratories at Manchester.

LAND-GRANT COLLEGE EDUCATION, 1910 to 1920, forms the subject of a series of studies which are being published by the United States Bureau of Education. The institutions known as Land-Grant Colleges were founded under the Morrill Act of 1862 and subsequent acts which provided for their endowment by grants of land by the Federal Government to the States, the primary object of the endowment being to ensure the teaching of "such branches of learning as are related to agriculture and the mechanic arts, in . . . order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life." They include 26 State universities, 17 institutions for coloured persons, and 26 other land-grant colleges. They are educating approximately one-third of all college or university students in the United States and three-fourths of all those trained at publicly controlled colleges and universities. Their total enrolments during the ten years 1910-1920 increased by 78 per cent.: the number of their women students doubled during the same period. It is obvious that they must have already exerted important influences on national development, and the importance of their functions ever tends to increase as the necessity for husbanding the natural resources of the country becomes more urgent. At the present rate of increase of the population, the United States will within about twenty years become a food-importing nation unless extraordinary efforts are made to increase production upon the present acreage.

Early Science at Oxford.

October 6, 1685. The Minutes of July 28th, 1685, being first read, the Secretary in ye name of Dr. Peirce of Bath presented ye Society with ye *shell* found by ye Doctor in ye kidney of a woman, and described in the *Philosophical Transactions*, No. 171, which very curious present was ordered to be repositied in the Musæum Ashmoleanum.

A letter from Dr. Middleton dated August 8, 1685 was read, it brought us a letter from Dr. Garden to Dr. Middleton concerning two monstrous Children lately born at Aberdeen; concerning the Sucker or Proboscis of ye Bee, and the Instruments, by which they break ye globulets, (or little bags of liquors) taken from the flowers, and prepare their wax: and also concerning ye circulation of ye blood, easily seen in ye *Lacerta Aquatica* by reason of its transparence.

A letter from Mr. Ja: Aston to Dr. Bathurst, dated Whitelackenden Oct: 1 1677, was communicated us from the Doctor. It gave an account of three Persons (one Man and two Women) in ye house of Mr. Speke of Whitelackenden taken with fitts, which came and went off in all and every one of them, though in distant places, at ye same time, and with the same symptomes; insomuch that if one laught, sung, curst, or ye like, the rest did so also.

Mr. President presented a booke, ye author Richard Norris, it treated of his manner of finding ye true sum of ye infinite of an arch, by an infinite series.

Proposals for printing Mr. Ray's History of Plants, together with a pattern of it, were presented.

October 7, 1684. Mr. Anderton, having formerly been admitted, acquainted ye Society, that a *spout* of rain fell between Farnborough, and Brittleton, in Barkshire, ye 3rd of May last; that ye fall of ye water was so violent, as to beat its way into a house on the top of a hill.

He says farther, that a woman near him in ye country, did, at 60 years of age, give suck to a little child; tho she herself had no child, nor given suck, for many years before.

Dr. Plot communicated an account of ye weather here at Oxon; in September last; He presented us with some of ye East Indian Bange, which is ye leaf of a tree taken commonly by ye inhabitants at their feasts; it is said to intoxicate, and put every man in his particular humor.

He also communicated an abstract of a letter, sent him by Mr. Todd, dated September ye 7th, from Rose Castle in Cumberland, concerning a salt spring, and another (Minerall) spring near Durham; as also concerning some Roman Urns which he promises to send us. Mr. Todd says in this letter, that as he traveld over Stane-Moor in Yorkshire, he observ'd ye River Greatah (which is about half as big as the Charwell) run underground for about a mile, so that he, and his company, past over it drye foot. The passage under ground is but narrow; so that in winter, when the streams are high, it keeps ye channell above ground.

October 13, 1685. A discourse entituled *Logica rerum* composed by Mr. Foley, Member of ye Dublin Society, and by him dedicated to ye Royall Society, was presented and read, and ye thanks of this Society ordered for it.

The Figures of some antiquities cheifly Roman, communicated by a Member of ye Royal Society were communicated.

A farther account of ye Aqueduct about Versaille was read; as also was a letter of Dr. Lister's to Mr. Ray, concerning some addenda to the *Ornithology*.

ERRATUM.—In this column of September 12, p. 415, line 12 from bottom, for *erythmiformis* read *crythmiformis*.

Societies and Academies.

PARIS.

Academy of Sciences, August 10.—The president announced the death of Hugo Hildebrand Hildebrandsson, correspondent for the section of geography and navigation.—André Blondel: The determination of the coefficient of hysteresis by means of apparatus with a rotating magnet.—Amé Pictet, Werner Scherrer, and Louis Helfer: The presence of argon in living cells. The presence of argon in yeast and in sheep's brain has been proved: further experiments are in progress to determine the origin of this gas.—C. Gutton and E. Pierret: The perturbations at the extremities of a line which is the seat of stationary electromagnetic waves. From a study of the harmonics the perturbation at the extremities of a line can be determined, and a curve or a table constructed giving the value of the perturbation for different wavelengths.—A. Grumbach and S. Schlivitch: The variation of the surface tension of liquids under the influence of radiation. The ordinary method based on the rise of a liquid in a capillary tube is not sufficiently sensitive to show the effect of radiation. A new method is based on the fact that if a drop of liquid is introduced into a horizontal capillary tube, and the surface tension of one meniscus is altered, the drop will move in the direction where the surface tension is greatest. In the experiments described one meniscus was exposed to the light of a mercury lamp; water, alcohol, and xylene were not displaced, but motion was observed with several liquids, including ordinary petroleum, aqueous or alcoholic solutions of fluorescein.—H. André: Conductibility by metallic colloids and its electro-technical applications.—W. Kopaczewski: Turgoelectricity.—J. Bougault: An example of ether-oxide ketone hydrate. The benzylphenylethylsuccinic acids.—Louis Glangeaud: The existence of the Aptian in the coast region of the province of Algiers and on its tectonic signification.—V. Agafonoff and Mlle. Malichef: The brick earth and ergeron of the plateau of Villejuif.—Mlle. Aimée Camus: *Hitchcockella*, a new genus of Madagascan bamboo.—Charles Kayser, Mlle. Eliane Le Breton, and Georges Schaeffer: Magnitude of the respiration of the tissues and active mass in the course of the development of organisms. The elementary respiration of homologous tissues of different individuals of the same species is greater the younger the organisms.—J. G. Szuman: The structure of the membrane separating the white and the yolk of the egg. P. Petit: The liquefaction of starch paste. G. Guittenne: The transformation of sulphur into sulphate by microbial association. The conversion of sulphur into sulphates is the work of two distinct races of organisms: one converts the sulphur into thio-sulphate, the other thiosulphate into sulphate.

August 17.—H. Deslandres: Complementary researches on the structure and distribution of band spectra.—Mlle. Sylvie Creanga: New properties of curves of constant normal curvature; their rôle in the representation of surfaces on parallel surfaces. Applications.—Ragnar Frisch: The semi-invariants of Thiele.—André Bloch: The non-uniformisability by meromorph functions of the most general algebraic varieties. N. Lusin: The problem of Emile Borel and the method of resolvants.—A. Dauvillier: Researches on the Crookes tube.—Y. Rocard: The diffusion of light and ratio of the absolute retardations in Kerr's phenomenon.—R. Fosse and A. Hieulle: The identification of glyoxylic acid by the action of hydrazine and xanthidrol, with

production of the dixanthylhydrazone of glyoxylic acid. The new substance is a definite crystallised compound, $[O(C_6H_5)_2CH]_2 = N-N=CHCO_2H$, and serves to detect 1.0 mgr. to 0.1 mgr. of glyoxylic acid in dilutions of 1 in 100,000.—William Herbert Hobbs: The asymmetry of the atmospheric circulation.—E. Rothé, J. Lacoste, and Mme. A. Hée. Earthquakes in France in 1924. A description of 24 earthquakes, mostly in the neighbourhood of the Pyrenees.

SYDNEY

Linnean Society of New South Wales, July 29.—H. J. Carter: Revision of the Australian species of *Chrysobothris* (Buprestidae), together with notes and descriptions of new species of Coleoptera. Nineteen species are described as new, including five Buprestidae, two Lucanidae, ten Tenebrionidae, and two Cistelidae. Keys are given for identification of species of Nyctozoisus and Seirotrana.—E. Cheel: Two new species of Callistemon, with notes on certain other species. One of the new species is nearest to *C. lanceolatus* and has been obtained from a number of localities in New South Wales and also in Gippsland; the type is from Nattai River. The other is from North Queensland and shows some resemblance to *C. linearifolius* and *C. rigidus*, but is distinguished by the less prominently veined leaves, paler filaments, and differently shaped fruits.—G. H. Cunningham: Gasteromycetes of Australasia. ii. A revision of the genus *Tulostoma*. The characters of generic and specific value are described; three species and one variety are described as new.

VIENNA.

Academy of Sciences, July 9.—J. Pollak and E. Gebauer-Fulnegg. On the action of chlorosulphonic acid on phenols.—E. Riess. On derivatives of the three cresols and of phenol. Disulpho-chlorides, sulphonylides, and neutral sulphuric ester are formed.—O. Tomaschek. On Exner's polarimeter and a way of applying this instrument.—F. E. Suess. Report on a geological excursion to Hauzenberg in the Bavarian forest: a contribution to the tectonic of granite.—E. Muller. Mid-point surfaces and a relative theory of surfaces.—K. Fritsch. Contributions to our knowledge of Gesneriaceae, the species of the genus *Napeanthus*.—O. Dischendorfer. Researches in the domain of vegetable chemistry. On the amyrin of elemi resin.—E. A. W. Schmidt. Communication of the Radium Institute, No. 178. Action of α -rays on aluminium. Radium C and polonium were used as sources of α -rays and the effect on H-particles explored.—M. Blau. Radium Institute, No. 179. On the photographic action of H-rays from paraffin.—G. Kirsch and H. Pettersson. Radium Institute, No. 180. On the reflection of α -particles at atomic nuclei. Reporting on experimental results of the retrograde method, it seems that for internal collisions between α -particles and atomic nuclei the energy and impulse law is not valid if only the α -particle and the nucleus are considered. Atom shattering with surrender of protons seems an attainable process for all elements by bombardment with α -rays. Various money grants are reported, including those to A. Ginzberger for publications on the change of species on islands, to F. Lieben for researches on the relations between the kreatin-kreatinin transformation and the sugar transformation, and to R. E. Mark for researches on the action of insulin on the linkage of sugar and phosphoric acid in the animal organism.

Official Publications Received.

University of Manchester: Faculty of Technology. Prospectus of University Courses in the Municipal College of Technology, Manchester, Session 1925-26. Pp. 323. (Manchester.)
Agricultural Research Institute, Pusa. Bulletin No. 186: Bud and Boll-Shedding in Cotton, a Preliminary Enquiry. By G. R. Hilson, V. Ramaswathi Ayyar and R. Chokalingam Pillai. Pp. 34+8 plates. 14 annas; 1s. 6d. Bulletin No. 187: The Experimental Sullage Farm, Lyallpur. By Dr. F. E. Lander. Pp. 25. 15 annas; 1s. 8d. Bulletin No. 188: A new Fodder (Silosd Shukam Leaves) for Dairy Cows. By Dr. F. E. Lander and Pandit Lal Chand Dharmani. Pp. 11. 6 annas, 8d. Bulletin No. 189: Preliminary investigations in the Bacteriology of Milk. By J. H. Walton. Pp. 14+2 plates. 6 annas, 8d. (Calcutta: Government of India Central Publication Branch.)
Colony of the Gambia. The Annual Report of the Department of Agriculture for the Year 1924. Pp. 44+2 charts. (London: The Crown Agents for the Colonies.) 5s.
Anales del Museo Nacional de Historia Natural Bernardino Rivadavia, Buenos Aires. Tomo 82. Pp. xxiv+526+8 láminas. (Buenos Aires.)
Fifteenth Report on the Sarawak Museum, 1924. By E. Banks. Pp. 11+33. (Kuching, Sarawak.)
Zoologica Scientific Contributions of the New York Zoological Society. Vol. 4, No. 8. The Galapagos Tortoises in their Relation to the Whaling Industry. By Charles Haskins Townsend. Pp. 55-135. (New York.)
Department of the Interior. Bureau of Education. Bulletin, 1925, No. 12: Statistics of State Universities and State Colleges for Year ending June 30, 1924. Pp. 11+23. (Washington: Government Printing Office.) 5 cents.
Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 508: Spark Photography and its Application to some Problems in Ballistics. By Philip F. Quayle. Pp. 287-276. (Washington: Government Printing Office.) 20 cents.
U.S. Department of Agriculture. Farmers' Bulletin No. 1456. Homes for Birds. By E. R. Kalmbach and W. L. McAtee. Pp. 11+21. (Washington: Government Printing Office.) 5 cents.
East Anglian Institute of Agriculture, Chelmsford (Essex Agricultural Committee) Calendar, 1925-26. Pp. 150. (Chelmsford.)
The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 35, January to June, 1925. Pp. 108+22 plates. (London: Royal Anthropological Institute.) 15s. net.
County Borough of West Bromwich. Technical School Prospectus, Session 1925-26. Pp. 60. (West Bromwich.) 5d.
Transactions of the Leicester Literary and Philosophical Society, together with the Council's Report and the Reports of the Sections, 1924-25. Vol. 28. Pp. 97. (Leicester.)
Bergens Museums Aarbok, 1925-1924. 2 Hefte. Naturvidenskabelig Række. Pp. 39+57+8+33+4+32. (Bergen.)
Bergens Museums Skrifter. Ny Række. Bind 8, No. 2: Bæltung zur Kenntnis einiger hermaproditischen dekapoden Crustaceen. Von Sven Runnstrom. (Mitteltung Nr. 61 der biologischen Station des Museums zu Bergen.) Pp. 115-8 Tafeln. (Bergen.)
Transactions of the Institution of Chemical Engineers. Vol. 2, 1924. Pp. 110. (London: Abbey House, Westminster.)
The National University of Ireland. Calendar for the Year 1925. Pp. viii+324+395+136. (Dublin.)
Hull Museum Publications. No. 140: Numismatic Notes. Edited by Thomas Sheppard. Pp. 29. (Hull.)
Transactions of the Yorkshire Numismatic Society. Vol. 2, Part 5. Edited by Thomas Sheppard. Pp. 160-224. (Manchester: Sherratt and Hughes.) 5s.
Transactions of the Hull Geological Society. Vol. 6, Part 5, 1922-1925. Edited by T. Sheppard. Pp. 250-296+xi. (Manchester: Sherratt and Hughes.) 5s.
Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 7, No. 7: The Phosphate Nodules of Trichinopoly and the Availability of Flour Phosphate as a Manure for Paddy. By Rao Sahib M. R. Ramaswami Sivan. Pp. vi+145-200+8 plates. 1.4 rupees. 2s.
Bacteriological Series, Vol. 2, No. 1: Nitrogen Fixation in the Punjab. By Dr. P. E. Lander and Barkat Ali. Pp. 28. 8 annas; 10d. Entomological Series, Vol. 8, Nos. 10 and 11. No. 10. Papers on Indian Tabanidae. iv: The Head and Mouth-Parts of the Larva of *Tabanus rubidus*, Wied. (= *Atherix*, Wik.). v: The Mechanism of Suction in the Larva of *Tabanus telus*, Wik. vi: The Male and Female Genitalia of *Tabanus telus*, Wik. vii: Notes on the Life-History of *Tabanus strabus*, Fabr. (= *Hidaria*, Wik.). By P. V. Iqbal. No. 11. Some Indian Species of the Dipterous genus *Atherix*, Rondani. By J. R. Malloch. Pp. 93-126+plates. 11-18. 1.8 rupees. 2s. Entomological Series, Vol. 8, No. 12: The New Mealy Scale (*Psittiraria maxima*, Green). By T. V. Ramakrishna Ayyar. Pp. 127-165+plates. 10-78. 1.4 rupees. 2s. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.)
Ceylon Journal of Science. Section B. Zoology and Geology. Spolia Zeylanica. Edited by Dr. Joseph Pearson. Vol. 13, Part 2, July 31st. Pp. 143-260. (Colombo: Colombo Museum, London: Dulau and Co. Ltd.) 3 rupees.
Catalogue of Indian Insects. Part 6. Staphylinidae. By Malcolm Cameron. Pp. ii+126. 1.14 rupees; 8s. 3d. Part 9. Zygomyidae. By T. Bainbridge Fletcher. Pp. ii+92. 1.5 rupees; 2s. 8d. (Calcutta: Government of India Central Publication Branch.)
Aeronautical Research Committee. Reports and Memoranda, No. 947 (Ae. 167). The Interference of Wind Channel Walls on the Downwash Angle and the Tail-rotting to Trim. By H. Glauert and A. S. Hartshorn. (A.S. Mus. Model Experiments, 48—T. 1891.) Pp. 9+4 plates. (London: H.M. Stationery Office.) 6d. net.
The Royal Society of Medicine. Calendar 1925-1926. Pp. 74. (London: 1 Wimpole Street.)
Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 49 (Botanical Section): Mycological Work in Egypt during the Period 1920-1922. By H. R. Britton-Jones. Pp. viii+129+10 plates. (Cairo: Government Publications Office.) 5 P.T.

Apia Observatory, Apia, Samoa. Upper Air Observations, 1924-1924. By Andrew Thomson. Pp 31. (Apia.)

Cawthron Lectures, Vol 2. No 1. The Geology of Nelson, by Dr P Marshall, No 2. The Coming of the Maori, by Te Rangi Hiron. Pp 56+16 plates (Nelson, N.Z.: Cawthron Institute.)

Smithsonian Institution United States National Museum Bulletin 129 The Spider Crabs of America. By Mary J. Rathbun. Pp xv+618+288 plates (Washington Government Printing Office.) 2 dollars.

Smithsonian Miscellaneous Collections, Vol 77, No. 4. An Introduction to the Morphology and Classification of the Foraminifera. By Joseph A. Cushman. (Publication 2824.) Pp 77+16 plates (Washington Smithsonian Institution.)

Catalogue of the Ceramic Library, Central School of Science and Technology, Stoke-on-Trent, including the Solon Library, the Ceramic Society's Library, and the Library of the Pottery Department of the school. Pp 14+228 (Stoke-on-Trent.)

Annual Report of the Meteorological Observatory of the Government-General of Chosen for the Year 1924. Pp 14+4+143 (Yokohama.)

The Calendar of the London School of Economics and Political Science (University of London) for the Thirty-first Session, 1925-26. Pp. 293+111 (London Houghton Street, Aldwych.) 3s 6d.

Aeronautical Research Committee Reports and Memoranda, No 932 (A 135) Experiments on a Model of a Bristol Fighter Aeroplane (1/10th scale) Section 1 Force and Moment Measurements at various Angles of Yaw. By H. B. Irving and A. S. Batson. Section 2 Lateral Derivatives by the Forced Oscillation Method, By R. A. Fraser, A. S. Batson and A. O. Gadd. (13g Complete Models, 58-7 1930.) Pp. 40+14 plates. 2 net Reports and Memoranda, No. 959 (M 36) A Method of Improving the Properties of Aluminum Alloy Castings. By N. L. Archbutt. Pp 10+4 plates 1s net (London I.I.M. Stationery Office.)

Cornell University Agricultural Experiment Station Bulletin 427 Farm Motor Trucks in New York. By V. B. Hart. Pp 50 Bulletin 428 The Clover-Seed Caterpillar. By Lawrence Paul Wehrle. Pp 34 Bulletin 430 An Economic Study of Rural Store Credit in New York. By Leland Spencer. Pp 47. Bulletin 431 The Cost of Laying in a small Factory Town. By Clarence Vernon Noble. Pp 70 Bulletin 432 An Economic Study of Dairying on 163 Farms in Herkimer County, New York. By E. G. Mieser. Pp 59 Bulletin 433 Economic Studies of Dairy Farming in New York. 2 Grade A Milk with and without Cash Crops. By E. G. Mieser. Pp 147 Bulletin 434 Experiments in Crop Rotation and Fertilization. By R. G. Wiggins. Pp 56 Bulletin 435 The Organization and Development of Co-operative Fire Insurance Companies in New York. By R. W. Bartlett. Pp 36 Bulletin 436 Results of Experiments with Cows in New York. By H. H. Love and W. T. Craig. Pp 34. Bulletin 437 Feeding Work Horses. By M. W. Harper. Pp 54. Bulletin 438 Economic Studies of Dairy Farming. 2 Grade B Milk with Alfalfa Roughage. By E. G. Mieser. Pp 104 (Ithaca, N.Y.)

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Bulletin of the Experiment Station of the Hawaiian Sugar Planters' Association. Agricultural and Chemical Series, Bulletin No 49. The Influence of Aluminum, Manganese and Iron Salts upon the Growth of Sugar Cane, and their Relation to the Fertility of Acid Island Soils. By W. T. McGeorge. Pp v+95 (Honolulu, Hawaii.)

Birkbeck College (University of London) The Calendar for the Year 1925-26 (103rd Session) Pp 14+201 (London.)

Department of Scientific and Industrial Research Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1924, with Report of the Geological Survey Board and Report of the Director. Pp 14+151 (London B.M. Stationery Office.) 2s 6d net.

Forest Bulletin No 62 (Silviculture Series) Preliminary Yield Table for *Dalbergia sissoo*. By S. H. Howard. Pp 6 (Calcutta: Government of India Central Publication Branch.) 2 annas, 3d.

Koninklijk Meteorologisch en Meteorologisch Observatorium te Batavia Verhandelungen No 15 Ueberbreiding van regenbuien te Batavia (Extension of Rainshowers at Batavia) Door Dr J. Boersma. Pp 11+64 (Wetlevreden - Albrecht and Co.)

Conseil Permanent International pour l'Exploration de la Mer Bulletin Hydrographique pour l'année 1924 Pp 84 (Copenhagen And: Fred Hest et fils.)

Memoirs of the Indian Museum Vol 8, No 5. Anatomy of the common Indian Apple Snail, *Pila globosa*. By Dr B. Prasad. Pp 91-154+plates 16-14 (Calcutta Zoological Survey of India.) 3s 8pence.

Lunacy and Mental Deficiency The Eleventh Annual Report of the Board of Control for the Year 1924 Pp 14+451 (London: H.M. Stationery Office.) 12s 6d net.

Diary of Societies.

SATURDAY, OCTOBER 3.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Joint Meeting of the North-Western and Yorkshire Districts) (at Todmorden), at 2.30 — R. H. Matlock, R. Bruce, and others. Discussion on Regional Town Planning.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton) — Conference on Smoke Abatement.

SUNDAY, OCTOBER 4

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton) — Conference on Smoke Abatement.

MONDAY, OCTOBER 5

SOCIETY OF ENGINEERS (at Geological Society), at 5.30. — Major V. A. M. Robertson. Bridges their Renewal in England and France during the Great War.

JUNIOR INSTITUTION OF ENGINEERS (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.30. — J. D. Porteous. Responsibility.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton) — Conference on Smoke Abatement.

TUESDAY, OCTOBER 6

ROYAL SOCIETY OF MEDICINE (Orthopaedic Section), at 5.30. — A. S. Blundell Bankart. The Physiology of Muscular Action (Presidential Address).

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall, Westminster), at 7. — E. Ower. Practical Measurement of Air Flow.

INSTITUTE OF METALS (Birmingham Local Section) (at Chamber of Commerce), at 7. — Dr F. Johnson. Some Phases of Life in India.

ROYAL PHOTOGRAPHIC SOCIETY, at 7. — J. D. Johnston. In Search of the Picturesque (Lecture).

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30. — H. J. Young. Chairman's Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Automobile Club), at 8. — K. Thomas. The Automobile Engineer (Presidential Address).

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15. — Dr G. Rohmer. Hungarian Calendar Customs.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (Glasgow) LIVERPOOL PSYCHOLOGICAL SOCIETY (at Liverpool University). — G. O. Field. Inaugural Presidential Address.

WEDNESDAY, OCTOBER 7

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8. — Investigations into the Analytical Chemistry of Tantalum, Niobium, and their Mineral Associates. — Dr R. Powell and Dr. W. R. Schoeller. III — A New Method for the Separation of Tantalum from Niobium; IV — The Detection and Determination of Tantalum in Niobium Compounds. — Dr. H. B. Darnell. The Determination of Sulphates in Gun cotton. — C. O. Harvey. The Reduction of Chloric Acid and Chloric Acid by Ferrous Sulphate.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, OCTOBER 8

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers, 85 St. The Minories), at 7.30. — Dr J. L. Haughton. Chairman's Address.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 8 St. Martin's Place, W.C.2), at 8. — Dr H. H. Morgan. The Need for Research in the Oil and Colour Industry.

FRIDAY, OCTOBER 9

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30. — Technical Questions and Discussions.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30. — F. Mason. Some Notes upon the Value of the Institute of Metals to the Local Industries (Chairman's Address).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Royal Society of Arts), at 8. — Dr W. L. Gibbs. Aerosols in Industry.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30. — G. Glegg, G. H. Pooley, H. Lee, and — Goulden. Discussion on Penetrating Injuries of the Eye.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall, Westminster) — E. M. Bailey. The Scottish Shale Oil Industry.

PUBLIC LECTURES.

WEDNESDAY, OCTOBER 7

UNIVERSITY COLLEGE, at 5.30. — Prof. F. Weigart. The Photochemistry of Vision. — At 7. — A. H. Barker. The Heating Equipment of a Large Hospital.

THURSDAY, OCTOBER 8

UNIVERSITY COLLEGE, at 2.30. — Sir Flinders Petrie. The Making of Egypt. — At 5.15. — Dr. T. G. Pinches. Recent Discoveries in Babylonia. (Succeeding Lectures on October 15 and 22.)

KING'S COLLEGE, at 5. — Dr. O. Da Fano. The Histology of Nerve Tissues and Paths of Conduction in the Central Nervous System. (Succeeding Lectures on October 15, 22, 29; November 5, 12, 19, 26; and December 3 and 10.) — At 5.30. — S. Smith. The Seals of Western Asia.

FRIDAY, OCTOBER 9

BEDFORD COLLEGE FOR WOMEN, at 5.15. — Miss Hosgood. Caribbean Countries some special Geographical Problems.

SATURDAY, OCTOBER 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30. — Miss M. A. Murray. The Earliest Egyptians and their Remains.



SATURDAY, OCTOBER 10, 1925.

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Physiology and Athletics.

PROF. HILL'S address on "The Physiological Basis of Athletic Records," an abridgment of which appears elsewhere in this issue, affords another instance of the value of laboratory work and its application to practical problems. The investigations of the functions of the isolated frog's muscle which were almost notorious for their supposed uselessness, have laid the foundation of the later work on muscular exercises. Prof. Hill does not claim that physiology can teach us how to win races, or, what is more important to certain sections of the public, "how to spot winners." The physiologist can aid, however, in the selection of men and women who are likely to become successful in the field of athletics.

The measurement of the gaseous exchanges of the body have been used for some time as a means of investigating certain functions of the body. In the hands of workers such as Haldane, Douglas and Krogh, among others, these methods have yielded results which have led to an understanding of the functions of the circulatory and respiratory systems. Benedict and Cathcart, by direct and indirect calorimetry, showed how the metabolism of the body and the physiological cost of work might be studied. Prof. Hill, by measuring (a) the maximum oxygen intake (income) and (b) the maximum oxygen debt, has extended the scope of these investigations. The measurements afford a means of investigating not only the metabolic changes during exercise, but also of studying the recovery process in the tissues after exercise is over.

It is clear that the measurement of the oxygen used will enable us to estimate the physiological cost of work, but movement to be physiologically efficient must be carried out in a skilful manner. The athlete who is able to go into debt heavily for oxygen is not necessarily the most skilful. The degree of skill which is shown will depend on factors such as posture, co-ordination of muscles, and the integrative action of the nervous system. Even the most simple movements of the body will on analysis be found to be exceedingly complex, many factors being harmonised to bring about the unity of motion. The work of Marey and the Webers demonstrated, many years ago, that the mere act of walking involved not only movements of flexion and extension of the lower limbs, but also accompanying movements of the shoulders, arms, head and hips. At each step, oscillations of the hips, shoulders and head occur. The leg that is moving forward is accompanied by a forward movement of the hips and a backward movement of the shoulders, that is, a slight twist of the trunk around a vertical axis. This torsion may be so exaggerated as to become very

apparent, but it is manifest to a slight extent even in normal walking, especially in women with a large pelvis. The torsion of the trunk and active oscillations of the upper limbs which balance the body increase on rapid walking. These accessory movements, unless reduced to a minimum, will lessen the efficiency of the movement and increase the physiological cost.

The muscular system which controls voluntary movement may be divided into three parts: (1) the prime movers, (2) the antagonists, and (3) the synergic group of muscles. Flexion of a limb is brought about by the contraction of one set of muscles, the flexors, and relaxation of the opposing set or extensor muscles, the two groups working in harmony. This dual action is essential and is found in every voluntary movement. To allow the third group, the synergic muscles, to function in a co-ordinated manner with the prime movers and antagonists, the limb or body must adopt the correct position. The action of the muscles, as pointed out by Magnus, depends on the posture. Bedale and Cathcart have recently investigated the physiological cost of work, by indirect calorimetry, in different types of weight-carrying, and their results show that the cost of work varies with the same load according to the posture adopted.

The body controls the movements of muscles and the posture of the part by the action of the nervous system. The regulating mechanism involved has been termed by Sherrington "the proprioceptive system," and includes nerve fibres from the muscles, tendons and joints, the internal part of the ear, and the external muscles of the eye connected through the various regions of the brain. In maintaining balance and posture each organ plays a definite part, regulating position, judgment of distance and the co-ordination of movement. The interaction and co-ordinated mechanism of these systems can be demonstrated by any skilled act, as, for example, movements of the expert skater in cutting a figure on the ice. It is impossible at the present time to express these various factors in measurable terms, but the investigations of the oxygen consumption correlated with the speed of movement gives a basis for discussion. It must be clear that a first-class athlete who is capable of breaking records does possess a high degree of skill in his movements. A man who is capable of establishing a large oxygen debt may become a record-breaker if he can be taught how to use his limbs to the best advantage. The elimination of unnecessary movements is receiving attention in the fields of athletics and industry. Slow motion photography and motion study are means by which the movements may be studied and faults corrected.

There still remains a factor of which we have little

knowledge, namely, the determination to win. How often is form upset on the racing track through a man losing his will to win at the psychological moment. This faculty, vague and indefinite as it may be, undoubtedly plays an important part in athletic life.

The comparisons drawn between men and women will be hotly contested, and Prof. Hill is a brave man to express the female performer as a fraction of a man. Certain anatomical differences in structure of men and women are known and probably militate against the female athlete. The flat female pelvis allows greater torsion of the trunk on exercise, and accessory movements of this nature will interfere with speed of action. Again, it is not clear that women up to the present have given as much time and attention to sport as men, and improvement is likely to be made by training and physical culture. Prof. Hill has arranged to carry out further work on this subject, and the results will be awaited with interest.

Fossil Insects of the Carboniferous Period.

A Monograph of the Fossil Insects of the British Coal Measures. By Dr. Herbert Bolton. Part 1. Pp. 80 + 4 plates. Part 2. Pp. viii + 81-156 + plates 5-10. (London: Palaeontographical Society, 1921-1922.)

PALAEONTOLOGISTS are now aware that, at the epoch when the coal beds of the Carboniferous Period were deposited, the arthropods were the first of all living creatures to gain the conquest of the air—these insects bore sway in that silent domain which as yet the birds did not dispute with them. This most ancient world of insects has been revealed by the progress of study as of so special a character that it cannot be brought within the narrow limits of the zoological classifications of the present day.

British palaeontologists possessed the honourable record, with regard to fossil insects, of having first discovered, early in the last century (1833), an impression of an insect in these carboniferous strata (*Lithosialis brongniarti* Mantell, 1854). They have now added to their list of successes a record which is still more glorious because it is due, not to chance, but to the sustained effort of one of their number—to-day the insect fauna of the British Coal Measures must be regarded as the best known of all those brought to light from all the Carboniferous basins of the world, thanks to the scrupulous and patient work which Dr. Herbert Bolton, director of the Bristol Museum, has carried out during close on twenty years.

The following figures will speak for themselves: in 1908, when Dr. Bolton began his investigations, only

thirteen species of fossil insects were known in the Coal Measures of Great Britain; Dr Bolton's researches have increased their number at the present day to almost sixty different species, contained in the five principal groups of these insects.

Dr Bolton has lately collected together the result of his studies in the remarkable monograph before us. This work does the greatest honour to British science. It is accompanied by a perfect set of figures consisting first of an actual reproduction, somewhat enlarged, of each specimen, due to the photographic skill of Mr. W. J. Tutcher, and giving a good idea of the exact nature of the impression, and secondly, of an outline drawing in which the author indicates the manner in which he has read the structure; thus the actual record is well separated from the interpretation. This is accompanied by a very precise description in the text. Dr. Bolton's monograph is thus of very great documentary value, and a model to all palæontologists for their descriptions. We can well imagine what an amount of effort and of patient criticism the author must have needed in order to present this memoir to the world of science. The difficulties must have been very great: it must be remembered that very small portions of the body of these creatures have been found, often only a tiny fragment, and these have been subjected to great pressure changes. When to this is added that in structure and relationship they differ widely from living forms, we cannot repress legitimate wonder that it has been possible, as with a magic wand, to bring to life, from a few fragments of stone bearing obscure impressions, so varied a swarm of unknown insects.

The greater part of this winged company revealed to us by Dr. Bolton's memoir is placed in the order Palæodictyoptera—he groups together the most curious of these insects, because they are the simplest, probably the oldest, and because they have no equivalents in Nature to-day, not having survived the Palæozoic era. Dr. Bolton describes nineteen species of them. These creatures appear to have flown, in large numbers and great variety, above the coal-swamps of Great Britain. They are provided with three pairs of wings possessing a very simple nervation, and with three pairs of legs, one pair of wings and legs to each thoracic segment. The legs are all alike; the first pair of wings (on the pronotum) is very much reduced, the hinder pairs only being functional; no specialisation of the organs of the mouth. The development is direct, without metamorphoses. In short, it appears as if these ancient Palæodictyoptera had almost exactly realised the *protentomon* formerly dreamed of by entomologists as the ancestral synthetic type of the Hexapods. Their size is variable and may reach a span of wing of about

30 cm. (*Hypermegethes northumbriæ*, Bolton) and even 70 cm. (*Archæoptilus ingens*, Scudder).

Besides these insects, also flying over the swamps and equally good sailers, were rarer forms which appeared later, more highly specialised and more similar to the insects of to-day: the dragon-flies. *Boltonites radstockiensis*, Bolton, found in the Upper Coal Measures of Somersetshire, is one of these curious Protodonata of large size (span of wing 40 cm.).

Following upon the Palæodictyoptera, the author describes a remarkable series of insects which Dr. A. Handlirsch, the Viennese entomologist, has placed in the two orders Protorthoptera and Protoblattoidea. As the names indicate, these insects are "generalised" types, very near to the living Orthoptera. Dr. Bolton describes eight species of Protorthoptera from the British Coal Measures.

Finally, an important section of these fossil insects (nearly twenty species) is formed by the cockroaches which, in the Coal Measure forests, under vegetable debris, lived in such large numbers and with so many varieties that Dr. Handlirsch has proposed to form a special order (Blattoidea) intended to contain them. S. H. Scudder was right in calling the Carboniferous Period "the era of cockroaches." Dr. Bolton has recognised that the English types had the closest relationship with those which we have described in the Coal Measure basin in the north of France. These innumerable cockroaches, the most minute details of whose organisation are known, are, except for a few primitive characteristics, constructed exactly after the same type as their rarer descendants of to-day. The latter, since the Carboniferous Period, have shown themselves proof against all evolution. They are *permanent* organic types, even more suggestive than the Lingula, often quoted on this account, for this is a case of animals which are very sensitive to change of surroundings, and very easily linked up with them.

Thus palæontology rehabilitates the cockroaches. They are far from meriting our scorn, for they are of aristocratic descent and the most conservative of all creatures. Is it in memory of the "Paradise Lost" of the Coal Measure forest where they reigned supreme, that they have become with most people the emblem, the *bête noire*, of their melancholy?

No insect in all the Coal Measure fauna is found undergoing complete metamorphoses, passing through the stages of caterpillar and of chrysalis before reaching the adult winged form. Dr. Bolton figures the larvæ of the Palæodictyoptera and of the cockroaches found in the English basins, which differ from the adult forms only by the lesser development of the wings, not in shape. The metamorphic insects (Holometabola) did not appear until the beginning of the Mesozoic Period,

at the same time that the seasonable alternations of heat and cold were produced. Doubtless there is a relationship of cause and effect. At any rate, the definition of a butterfly made by a French poet does not, according to the witty remark of Prof. Ch. Barrois, apply to these Coal Measure insects which lived before the seasons and the flowers existed: "Naître avec le printemps, mourir avec les roses." These insects, made known to us by Dr. Bolton, were born and died before the world had known the first spring-time and the first rose.

The greater number of the coal basins of Great Britain, and almost all the levels of the Coal Measures, but principally the Upper (Middle and Upper Coal Measures), have yielded fossil insects. From the point of view of their stratigraphical distribution, Dr. Bolton has established facts similar to those which have been recognised in France, namely: (1) In the Lower Coal Measures the Palæodictyoptera predominate, and cockroaches are rare; (2) in the Middle Coal Measures simple Blattoidea are found such as the Aphthoroblattina, and Protoblattoidea such as Coselia; (3) finally, at the base of the Upper Coal Measures flourish the genera of Blattoids, Archymylacris, Phylomylacris, Soomylacris, etc. . . ., as in France, in the Bruay beds. Thus the Coal Measure insects, which have evolved rapidly, are excellent fossils characteristic of the successive horizons.

In his introduction, Dr. Bolton touches upon a certain number of theoretical questions, such as that of the origin (aquatic or terrestrial?) of insects, the origin of their wings (which appear merely as an exaggeration of the pleural expansions which all Palæozoic arthropods bear on their segments). But he does not linger over them, because he rightly prefers to produce a work of actual observation, and he examines in detail the interesting question of the faunal association of the Coal Measure insects only because he has found in the beds a whole series of instructive facts. The frequent association of fossil insects with the Myriapoda and the Arachnidæ in the ironstones reminds him of the colonies of spiders, millepedes, and cockroaches living under the bark of trees which he has observed in the bush country of Australia. Even under a tropical sun the nightly dew preserves during the day, in the low parts of the jungle, conditions of humidity favourable to the life of arthropods, which Dr. Bolton compares with those which must have prevailed at the Coal Measure Period.

Such are a few of the reflections suggested by the reading of this memoir. When one reflects that, among the seventy specimens of insects dug up from the coal basins of Great Britain, there are almost sixty different species, one is struck by the great diversity of this

vanished world. Almost every impression which is discovered reveals an unknown organic type, so that the number of forms which we do not yet know must be immense. Therefore Dr. Bolton encourages us to seek for them: "The fossil insects already found in the British Coal Measures form probably but a small fraction of those which remain to be discovered, when attention is more fully directed to them" (p. 3).

In thus concluding a work of such great value, the fruit of so much conscientious labour, Dr. Bolton could not more modestly or more wisely apply the precept, "The man who has finished has only just begun." We hope for the sake of palæontological science that Dr. Bolton's wish may be realised by himself.

P. PRUVOST.

Modern Meteorology.

- (1) *Dynamische Meteorologie*. Von Prof. Felix M. Exner. Zweite, stark erweiterte Auflage. Pp. viii + 421. (Wien: Julius Springer, 1925.) 24 gold marks.
- (2) *Les méthodes de prévision du temps*. Par J. Rouch. (Nouvelle Collection scientifique.) Pp. 280. (Paris: Félix Alcan, 1924.) 10 francs.
- (3) *Wellen im Luftmeer: neuere Untersuchungen über Gesetzmässigkeiten im Gange und in der Verteilung des Luftdruckes*. Von L. Weickmann. Erste Mitteilung: Symmetriepunkte des Luftdruckganges der Luftdruck als zusammengesetzte Schwingung. Pp. 46 + 6 Tafeln. (Leipzig: S. Hirzel, 1924.) n.p.

(1) **P**ROF. FELIX M. EXNER is known to be the author of some sixty original papers, joint author of a standard work on "Meteorologische Optik," joint editor of the *Meteorologische Zeitschrift*, and Director of the Austrian Zentral Anstalt für Meteorologie und Geodynamik. His "Dynamische Meteorologie" is regarded as important by meteorologists, and will probably also interest those who teach dynamics, because it is largely written in their style; the "soluble" problems of atmospheric dynamics being set out in neat mathematical language.

The early chapters expound fundamentals concerning the distribution of gravity, the thermodynamics of moist air, the dynamics of a fluid on a rotating sphere, and the statics of an atmospheric column. So far the topics are common to many books. Much of what follows is original; indeed, we know of no other book that overlaps to any considerable extent.

The best way of classifying the enormous heap of meteorological facts and theories is a puzzling problem of which Exner's solution is to head chapters thus: iv. Vertical Temperature Distribution in Equilibrium, v. Kinematics, vi. General Dynamics of Air Currents,

vii. Energy of Air Currents, viii. Steady Motion in the Atmosphere, ix. General Circulation of the Atmosphere, x. Dynamics of Cyclonal Motion, xi. Non-periodic Changes at one Place, xii. Non-periodic Changes on the Map, xiii. Periodic Changes in the Atmosphere. Many ordinary topics run on from chapter to chapter, for example, the modern work on cyclones will be found in Chapters xi. and xii. as much as in x.

Some of Exner's prettiest results are obtained on the hypothesis that the air moves adiabatically, without friction, at a speed which, in view of the earth's rotation, just balances the pressure gradient. Meanwhile every column is supposed to be in vertical equilibrium. He thus (§ 76) derives the remarkable equation

$$\frac{\partial P}{\partial z} \cdot \frac{\partial^2 P}{\partial \sigma \partial t} = g \left[\frac{\partial P}{\partial y} \cdot \frac{\partial^2 P}{\partial x \partial z} - \frac{\partial P}{\partial x} \cdot \frac{\partial^2 P}{\partial y \partial z} \right],$$

in which x, y, z, t are the co-ordinates, z pointing vertically, g is the acceleration of gravity, l is z (earth's angular speed) $\times$ (sine of latitude), and P is the 0.288th power of the pressure. From this he deduces (on p. 299) a rule that may be stated thus: "If the isobars turn with increasing height in the direction of the sun's apparent daily motion, then, in the region of their turning, the potential temperature is rising; and vice versa." Next this rule is applied (on p. 350) to explain why it is that a shallow unsymmetrical cyclone usually travels eastwards. Again (p. 381) the same ideas enabled Prof. Exner to forecast that a particular cyclone would move in the direction of the upper wind, westwards.

Those who follow Clerk Maxwell's tradition will regret to see left-handed axes on pp. 196 to 197. There appears to be a mistake in the kinematic conditions at an interface between hot and cold air on p. 313. The treatment of turbulence on p. 125 still contains the idea that lumps of air, like molecules, have a "mean free path," although nothing of the sort has been observed in the atmosphere, and G. I. Taylor has provided a theory of "Diffusion by Continuous Movements."

Considerable attention is given (in Chap. xi. and elsewhere) to the ideas about sliding surfaces, which, after coming down from Helmholtz via Margules, Exner, and Ficker, have recently been brought into relation with rain, and with forecasting by V. Bjerknes and his associates.

Another important allied topic is the conversion of heat-energy into mechanical energy in the atmosphere. English readers will welcome the extensive account of the researches of Margules and of Sandstrom. The point of the present reviewer's work, on the supply of energy to eddies, is unfortunately quite missed on p. 186. With regard to the energy of cyclones, Exner writes (in the preface):

"The question of the energy of winds in our latitudes was treated in the first edition entirely in the sense of Margules' work. Since then I have come more and more to comprehend, particularly through the influence of Alfred Wegener, that the aforesaid energy comes originally from the unequal supply of heat to the lower and higher latitudes of the earth, that is to say, from large circulating currents, a change whereby Margules' calculations of course do not lose the least part of their value. But in the new edition it will be found that the rôle of the exchange of air between the tropics and the polar latitudes is made more prominent and that cyclones and anticyclones appear as conditions of this exchange. This conception cannot be brought into complete harmony with Bjerknes' view of the stable polar front and the wave theory of cyclones. . ."

Mr. W. H. Dines showed that the correlation between pressure and temperature was about 0.9 at 9 km., and decreased gradually as the earth was approached. Prof. Exner exhibits (Fig. 95) and explains this decrease of correlation as due to a shift of phase between waves of pressure and of temperature. We seem to approach again to a wave theory of cyclones.

There are numerous interesting and original features which we have not room to mention. The book is a sort of museum full of standard types, obtained by imagining in turn various different restrictions in order to make the differential equations integrable. These types resemble events sometimes to be found among the multifarious behaviour of the actual atmosphere, and they greatly aid us to understand what happens. They do not provide a continuous account of its day-to-day progress. No integral formulæ could. It is to be hoped that some publisher may be persuaded to issue an English translation of this excellent book. It does not attempt to summarise the researches by many authors published recently in England.

(2) In comparison with Exner's great work, this of Rouch is a simple popular book treating historically in clear French, without mathematics, the various forms under which the problem of weather forecasting has been proposed, from the earliest times to the present decade. The outlook is practical. There are diagrams showing Bjerknes' rain-areas, Gold's fifteen types of isobars, and Schereschewsky and Wehrle's cloud-system. The author estimates that, of the forecasts made nowadays by any method for one day ahead, not more than seven out of ten are justified by the event, and he considers that the fraction of success has not increased much during the last fifty years, owing to the inherent difficulties of the problem.

(3) In this astonishing paper, L. Weichmann, Director of the Leipzig Geophysical Institute, asserts that it has been proved from the barograms of stations in middle latitudes of Europe, Asia, and North America, that there are certain dates such that the preceding

part of the barogram is the mirror image of the succeeding part, the mirror being placed parallel to the pressure axis. Such reflections occur at

July 4, 1922, in North America; Jan. 1, 1914, in Russia Nov 6, 1923, in Hamburg, Jan. 15, 1924, in Hamburg.

The correspondence of the "incident" and "reflected" portions of the barogram is said to extend over months in time, and over areas on the map as big as continents

A number of barograms and weather maps are pointed in support of this contention; and the degree of correspondence is tested by correlating the corresponding pressures. After a slight judicious stretching of parts of the time-axis when the air was cold, the correlation attains the value 0.7. It is pointed out that a reflection will occur if all the Fourier component waves into which the barogram can be analysed attain their extremes at the same instant. Harmonic analyses have been made of pieces of the barogram including 180, 90, or 72 days. This was done after the stretching referred to above. It is shown that five or more component waves attain their extreme values at times which agree within ± 1 day.

The author does not give an estimate of the probability of this being a chance occurrence. We may get an estimate thus. Suppose many waves of period T_1 days, with phases at random. The chance of an extreme (*i.e.* maximum or minimum) lying within ± 1 day of a given instant is $4 \div T_1$. If there are four other periods, T_2, T_3, T_4, T_5 , with phases independently at random, the chance that these extremes should all lie within the chosen 2-day interval is $4^5 \div T_1 T_2 T_3 T_4 T_5$. That is to say, such an event would occur by chance on the average once in $2 T_1 T_2 T_3 T_4 T_5 \div 4^5$ days. On this reckoning the coincidence shown in Weichmann's Fig. 18 would occur by chance once in six years on the average, if the time-axis were not judiciously stretched, and presumably more often when, as now, judgment comes into play.

L. F. RICHARDSON.

Stellar Spectra and the Physics of Gases at High Temperatures.

Stellar Atmospheres: a Contribution to the Observational Study of High Temperature in the Reversing Layers of Stars. By Cecilia H. Payne. (Harvard Observatory Monographs, No. 1) Pp. ix+215. (Cambridge, Mass.: Harvard Observatory; Cambridge: W. Hefner and Sons, Ltd., 1925.) 2.50 dollars.

IT is announced by the Director of the Harvard College Observatory that, in addition to its Annals, Circulars, and Bulletins, the Observatory will from time to time publish Monographs dealing with subjects in which the Observatory is doing a large amount of

original investigation. Unlike the Annals, etc., the Monographs will not be distributed gratis to observatories and others, but special funds are available to enable them to be published at less than cost price. The first volume of the series is Dr. Cecilia Payne's "Stellar Atmospheres."

Astronomers will welcome not only the announcement itself but also the choice of the first subject, and their expectations will be fully justified by a study of Miss Payne's book. "Stellar Atmospheres" should immediately take its place as an indispensable handbook for the stellar spectroscopist who wishes to have easy access to the series classifications of the spectra he is interested in on one hand, and to the latest deductions concerning the temperatures and pressures in stellar atmospheres on the other. Miss Payne has brought to her task an enthusiasm and a thoroughness which, with the wealth of observations contributed by herself, make her book at the same time an attractive story and a work of reference. It may be mentioned that there are more than five hundred references to the original literature, of which more than half are to the sources of spectral classifications and determinations of critical potentials.

Part I. is a concise study of the physics of the atom as regards the origin of line spectra and of the physics of stellar atmospheres in so far as this is known independently of the methods initiated by Saha. An account is given of the colour temperatures of the stars, and of the various lines of evidence which indicate the order of magnitude of the pressure in the reversing layers of stars, following Russell and Stewart. A qualitative account of the probable structure of a stellar atmosphere is followed by a useful synopsis of the elements that occur in stellar spectra and the series classifications of the relevant lines.

The core of the book is formed by Part II., which is concerned with the physical interpretation of the observed features of stellar spectra. Six years ago, practically no explanation existed of why some lines appear in stellar spectra and not others, why some lines always decrease in intensity through the stellar sequence and others appear, reach a maximum, and fade away again. It is to Saha that we owe the key which has unlocked these mysteries. Saha showed that elementary thermodynamics, considered in connexion with Bohr's theory of the origin of spectra, demands that atoms pass through successive stages of ionisation as the temperature increases, and that they must necessarily produce just that sequence of absorption spectra which is observed in the stars. At the hands of Saha and others, this simple physical idea has received quantitative treatment which allows a wealth of detailed deductions to be made concerning pressures and

temperatures in stellar atmospheres from the observed intensity changes in stellar spectra

Miss Payne has devoted her own labours to this object. She has tabulated her own measures of line-intensities for the different spectral classes. She has then deduced the scale of stellar temperature, refining the standard procedure by a method which takes account of the differing levels at which lines originate.

An observed maximum of a line in the stellar sequence determines a certain relation between the temperature and pressure at the level in the atmosphere at which the line originates when at its maximum intensity. If the temperature be taken to be known from the colour scale, an observed maximum fixes the pressure. Theoretically the pressure is a complicated function of the relevant atomic and stellar quantities. Among other things, it might be conjectured to be inversely proportional to the maximum concentration of the atoms in the appropriate excited state—the stronger the concentration, the less deep we can see into the star in the frequency concerned and the lower the pressure. Miss Payne tests this conjecture and finds it to be reasonably well satisfied. She therefore uses the empirical relation to construct the temperature scale for the hotter stars, for which trustworthy colour-temperatures are wanting.

The fact that the product of partial electron pressure and relative concentration of excited atoms at maximum is approximately constant is of considerable significance. It will be one of the prime objects of theoretical astrophysics in the immediate future to remove the empirical character from this "constant" and to calculate it in terms of the ordinary atomic and stellar quantities. The "constant" will, of course, be found to be a function of surface gravity and atomic absorption coefficient, and the possibility will arise of measuring either " g " for the stars or the absorption coefficient for the atoms from observations of maxima.

Perhaps the most stimulating portion of Miss Payne's book is Part III., which deals with special problems. She lays special stress on the circumstance that the lines of Sr^+ are in many respects anomalous—for example, on the high-temperature side of the maximum they would be expected to be weaker in giants than in dwarfs, on the usual theory, whilst the reverse is observed. The reviewer would suggest that in this case the dominant factor is not the concentration of suitable atoms. In the steady state, the residual intensity in the principal doublets of Ca^+ and Sr^+ cannot exceed the values just capable of supporting the corresponding atoms against gravity. Surface gravity being weaker in giants than in dwarfs, the residual intensity must be weaker in giants than in dwarfs. Thus the lines must cut deeper into the continuous spectrum of the giant

than of the dwarf, and they may in consequence appear stronger in spectrograms.

It is perhaps to be regretted that Miss Payne has not adopted a linear classification of the O-type stars—for example, the one suggested by H. F. Plaskett. This leads to apparent anomalies in some of the tables—for example, a temperature of $35,000^\circ$ is allotted to type O from the maximum of the He^+ lines, a temperature of $25,000^\circ$ to the same type from the Si^{+++} lines. Reference to the tables of measures of actual O-type stars removes the apparent inconsistency, but the suggestion might be made that in a future edition a division of the absorption-line O-stars into sub-classes, even a provisional one, would be a help to the reader. This would be more consistent with the plan of the book, which is primarily concerned with the temperature classification of stars on the basis of absorption lines.

The treatment of the physical basis of the dissociation formula, first used in this connexion by Saha, seems to the reviewer unsatisfactory. The author appears to consider that Saha's own justification for the formula was merely analogy with physical chemistry, in particular the physical chemistry of dilute solutions, and that it was thus based on the law of mass action, that the acquisition of a charge at dissociation is the only feature that "chemical" and "thermal" dissociation have in common, and that thermal ionisation is a process different from ionisation by collision, for example. But thermal ionisation is not a process—it is an equilibrium state. The mechanism by which the final state is arrived at consists in part of photo-electric absorption, in part of ionisation by collision, and so on. Each of these processes in the long run will set up of itself exactly the same final equilibrium state. This final state is one which can be predicted by pure thermodynamics, save for a constant of integration, and the general dissociation formula was in fact given by Willard Gibbs in 1875 and applied by him to the "thermal" dissociation of gases such as N_2O_4 . It is, of course, possible to make some progress towards the deduction of the dissociation formula by using the law of mass action, but then any equilibrium-state formula can be deduced via reaction velocities. The final state is, however, known independently of any assumption about reaction velocities or of the mechanisms of decomposition and recombination. The only doubt in the original application of the dissociation formula to high-temperature ionisation was the value of the above-mentioned constant of integration—the "chemical constant" of the electron. Statistical mechanics adds nothing whatever to the validity of the dissociation formula. But it succeeds in going a little further—it actually evaluates the constant.

The spectroscopic notation used is that recently suggested by Russell and Saunders, and it proves very

convenient for the purpose. There is, however, some inconsistency in applying it to the Balmer series. Thus in one place the series is described as $(2P - mD)$, whilst elsewhere the line $H\beta$ is described as $(1S - 2P)$. Surely the Balmer series should be described as the superposition of $(2P - mD)$ and $(2S - mP)$.

Space does not permit an account of the many other interesting subjects studied in the monograph, but reference should be made to the astrophysical determination of ionisation potentials, and also to the chapter on the relative abundance of the elements in stellar atmospheres, which consists entirely of Miss Payne's own work on the subject.

E. A. M.

Evolution and Popular Thought.

- (1) *The Earth Speaks to Bryan*. By Prof. Henry Fairfield Osborn. Pp. vii + 91. (New York and London: Charles Scribner's Sons, 1925.) 1 dollar.
- (2) *Concerning Evolution*. By Prof. J. Arthur Thomson. Pp. x + 245. (New Haven: Yale University Press; London: Oxford University Press, 1925.) 11s. 6d. net.
- (3) *Evolution in the Light of Modern Knowledge*. A Collective Work. Pp. xv + 528 + 4 plates. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1925.) 21s. net.

(1) **T**HE present widespread interest in evolution, largely due to recent events in the United States, manifests itself in the number of books addressed to the general reader which deal with evolutionary topics. "The Earth Speaks to Bryan" comprises five articles written for American newspapers and reviews apropos of the Tennessee anti-evolution trial. There is little doubt that, as Osborn believes, the trial has been a good thing for America. It has brought the chronic disease to a head and made the common people think about the whole issue. But in one respect it has had results which, to some at least, are not so desirable. So bibliolatrous is the general temper of many American States, and so anxious have some American men of science been to show that the teaching of evolution is not, as Mr. Bryan amazingly put it, essentially atheistic and immoral, that they have gone to the opposite extreme and tried to reconcile evolution and the Bible in every particular, and to gloss over the real differences which are inevitable between the supernaturalism of a revealed religion and the naturalism of modern science. Osborn seems to be in this category. He confuses religion with theism and apparently with Christianity, and belief in the soul as a psychological tenet with a belief in "the reality of moral and spiritual values." He goes so far as to say that the "proof," which he asserts has been furnished by palæontology, of the non-

fortuitous nature of variation (as to which proof most biologists would be in disagreement with him) brings us back to find Paley's argument for the existence of God "just as strong as ever it was" in pre-Darwinian days. He, of course, asserts that "God used evolution as his plan," as if this were self-evident, and actually states that the Bible is an "infallible (*sic*) source of spiritual and moral knowledge."

The merit of the book is its easy and vigorous style.

(2) Prof. Thomson has an equally easy style, but it sometimes has rather a fluffy effect. Perhaps he is too open-minded, and tries to do justice, a little too liberally, to everybody's views all round: and perhaps he writes too many popular books to preserve his native terseness. Otherwise his volume is an admirable summing-up, not too technical but not too popular, not ultra-modern and yet not old-fashioned, of his view of evolutionary biology. He also tries a fall with the old problem of religion and science, and comes to the characteristic conclusion that each is right in its own sphere. But when he says, "there is no possible way in which Science could disprove God," he has not concerned himself to point out that though this is in one sense a truism, yet science can disprove, and has disproved, many gods, and many assertions as to the attributes of God. As usual, Prof. Thomson is especially interesting in regard to animal behaviour.

(3) The third volume is by far the most ambitious. It contains contributions from thirteen scholars on different aspects of evolution, from cosmogony to anthropology, from physics and chemistry to philosophy and religion. Canon Wilson, in one of his broad-minded and reverent articles, traces the influence of the evolutionary theory on his mind from the time of the appearance of the "Origin of Species" (when he was already the science master at Rugby School!), through a period of doubt, to a new form of belief. It is interesting to hear that his mature belief took its source in reflections on the human spirit. This is religious naturalism, though the form of his belief be very different from that of many others who would start building their religion upon naturalistic foundations.

We are glad to see an article by another G.O.M., Prof. Lloyd Morgan—a sane and mellow article on general biology and the relations between mind and matter, with an interesting brief summary of the writer's views on emergence in evolution. Dr. Pembrey's article on physiology is interesting in itself, and also as showing how the influence of the theory of evolution upon this branch, at one time much less than that upon morphology, is to-day very strong, just at the time when many zoologists are hypercritical on

evolutionary matters. His discussion of the inheritance of acquired characters is vitiated by a certain vagueness consequent upon his taking no account of modern genetic work. Prof. McDougall has a rather sketchy article on mental evolution, and Prof. Taylor writes a long and not always easy essay on philosophy and evolution. At one point he makes the slip (p. 448) of omitting all the "orthogenetic" side of evolution, which has been emphasised in different ways by men so different as Huxley and Eimer, Osborn and Morgan. Prof. Soddy sums up evolution in physics and chemistry, but with very little reference to theories of cosmogony. Because now the only changes we can detect in the elements are degradative, that is no reason why in wholly different conditions, for instance of temperature, progressive and truly evolutionary changes in inorganic matter may not have occurred. Prof. Elliot Smith has a provocative article on anthropology. At one time he uses biological analogies in support of his theory of the spread of culture, while later he stigmatises such procedure as dangerous and misleading. It is rather amusing to find him laying down as obvious that similarity implies common descent, while in the same volume Prof. Bower in his article on botany is cautiously coming round from this to the idea of a parallel development in a whole group like ferns! We would also remind Prof. Elliot Smith, first, that Wheeler has made it clear that the social habit of ants, bees, and wasps has been acquired independently for each, and probably more than once in some of the three groups, and secondly, that the work of the Morgan school is showing that parallel mutations may occur independently in different species (e.g. of *Drosophila*, etc.). It behoves anthropologists, whose material is vaguer than that of the systematist, to walk rather more warily than they (or some of them) are, at present in the habit of doing.

Prof. Bower's article is rather more technical than most, and will be of more interest to biologists than to the general public. Prof. MacBride enters his usual plea for Lamarckism. It might be wise to lay less stress on Tornier's work as "proving" the inheritance of acquired characters and the origin of mutations, considering that it was never taken beyond *Fr!* The "indirect proofs of the inheritability of the effects of habit" are not proofs at all; and the remarks about mutation are very one-sided. At the close Prof. MacBride commits himself to the definite statement that the typical larva of molluscs and annelids represents an ancestral form, whereas it is at least equally probable that it is a special adaptation to dispersal, and there is, in the absence of fossils, no means of deciding which view is right!

The excellent articles by Drs. Jeans and Jeffreys on cosmogony and the evolution of the earth as a planet will be read with special interest, because of the great advances which have recently been made in these fields.

The book is in many details interesting. However, it can scarcely be said to fill the gap mentioned in the preface—the want of any recent authoritative statement on the subject of evolution by British naturalists. Too many of the writers have axes to grind in the shape of pet theories, and there is not enough of a central scheme running through the book, so that the articles are heterogeneous in nature. But it contains plenty of good reading, both for layman and man of science.

University Calendars.

The Calendar of the London School of Economics and Political Science. (University of London) for the Thirty-First Session, 1925-26. (London: London School of Economics and Political Science, Houghton Street, Aldwych, W.C.2, 1925.) 3s. 6d.

THE aim of a university is to supply information to its students, to train their intelligence, and to render them capable of doing and making things in the best way. This doing and making being the ultimate aim of a university education, it is not unreasonable to inquire into the success of a university when it is itself engaged in doing or making. A university does not often give the chance of this test, but every university does every year produce one book, its university calendar.

The members of a university do not inquire whether their own calendar is a satisfactory production. It may be that even the least patient of us can ascertain the contents of one ill-arranged book; it may be that a university has a few experts who make the information available for the rest; it may be that the handing down of the facts by oral tradition makes the study of the calendar unnecessary.

It is the man who has to study university calendars in bulk who is really in a position to see their merits and defects. Such a man, when he has to ascertain some point about a university, turns to the index of the calendar. In many cases the word sought does not appear in the index; in other cases it is there and gives reference to a number of pages none of which contain the information desired. The man then tries the index for all other possible keywords, but frequently with no better success. The investigator next turns to the table of contents. He tries first to ascertain the general arrangement in order to see in which division his point is likely to be found. There is usually no orderly arrangement. The principle of the calendar is often

that of the dust-heap. When anything has to be added to the calendar it is simply dumped on the top of the stuff already there. The investigator is thus compelled to read through the table of contents until he finds a likely item. The descriptions in the table are, however, so colourless and so inappropriate that he has to study quite a number of likely and unlikely items before he finally runs to earth the information he is pursuing.

There is probably no man in the United Kingdom who has more occasion to study university calendars than the present writer and three of his colleagues; and the foregoing description gives their experience down almost to the present day. The calendars of universities and colleges have hitherto shown such a dead level of badness that it has not been possible to pick out one as being either worse or less bad than the rest.

That time of dead uniformity is past. There is now one calendar that has evidently had some of the attention that an author is accustomed to bestow on his book. It has an index that functions; related portions are brought together; the table of contents gives evidence of an orderly arrangement; and the titles used for the various portions are reasonably descriptive of the contents of the portions. In the average calendar the title-page is lost among a mass of advertisements or other misplaced matter, and the beginning of the text is similarly concealed and has not the smallest fraction of a page left blank to show it up; so little do æsthetic matters appeal to the ordinary university. The calendar of the London School of Economics for the current year has a title-page at the place where one naturally looks for it, and by the use of appropriate type for the titles of divisions and subdivisions it shows up the orderly arrangement of the text. It has, in fact, some of the attractive traits which we expect to find in all proper books.

This calendar does not yet show much appreciation of æsthetic values. It would be improved by a more generous allowance of blank paper at the head of a page on which a chapter begins. The use, also, of appropriate blanks between sections of a chapter would have æsthetic value, and at the same time add to the clearness of the general plan of the calendar. The first step in reform has, however, been a long one, and we may hope that further steps will be taken, and that æsthetics will presently come into their own.

Some people uphold economics as a better training for most walks in life than the older studies. On that we express no opinion beyond inquiring whether it is a mere coincidence that this school of economics, which is not half a century old, should have been able to make of this calendar a pleasing book with its informa-

tion readily accessible, while the universities that have had centuries of experience in the production of calendars still give us the kind of abortion described above. However that may be, the wise university will study the calendar of the London School of Economics and see if it cannot do something on the same lines.

Financing Agriculture in North America.

Farm Credits in the United States and Canada. By James B. Morman. (The Rural Science Series.) Pp. xvi+406. (New York: The Macmillan Co., 1924.) 15s. net.

UNTIL the establishment, under Federal auspices in 1916, of the land banks and joint-stock land banks, the farmer in the United States obtained loans mainly from commercial sources and life insurance companies. The book under notice is a careful review in simple language of the gravely important consequences of the changes in the methods of obtaining credit facilities which these banks have introduced. The success of the land bank system, with its fixed maximum rate of interest, its appreciable reduction in the initial charges to the mortgagee, and its scheme for gradual repayment of the sum advanced, is evidenced by the value of mortgages taken out. In six years they have amounted to 90 per cent. of those accumulated in the life insurance companies in all their existence, which in some cases is more than fifty years.

This "success" is, in the author's opinion, a mixed blessing. Advances are much more easy to obtain, and although a farmer may obtain temporary relief from immediate embarrassments, he has nevertheless taken on an additional burden. It is not so much the interest as the debt itself that is the real trouble. Whether the debt be repaid in annual instalments or as a lump sum, the burden is intensified with lapse of time because of capital depreciation, a factor seldom considered by the farmer when negotiating the mortgage. Most forms of capital equipment are worn out or reduced to a nominal value in ten years, and unless depreciation has been allowed for, the farmer may find the temporary alleviation of his difficulties has, in the long run, intensified them. Even with the more equitable terms of the land banks, in which the provision for gradual repayment of mortgage is perhaps the most important, the proportion of failures to meet obligation is increasing.

The heavy load of debt is undeniable, and the author considers that for many years to come, United States agriculture, as a whole, will have to carry the heaviest financial burden of any industry, and this

in spite of the fact that more than 50 per cent. of owner-farmers are free from debt. It is satisfactory to record that Canadian systems of credit—especially short-time credit—receive favourable comment.

The most significant statement in the book is that mortgage credit agencies, however beneficial their intentions, are not to be compared in their usefulness and service to farmers with the agricultural colleges and experiment stations throughout the country. These institutions are helping the farmer to increase his income in various practical ways, and if they cannot rescue him from the dilemma in which he finds himself as the result of easier mortgage credit terms and conditions, he will find no relief anywhere. In view of the author's position of economist on the Federal Farm Loan Board, this considered statement of the limits of direct financial aid to agriculture must carry great weight.

Although the book does not discuss British conditions, it contains the material for useful analogies, as well as much of direct interest to agricultural economists on the eastern side of the Atlantic.

B. A. K.

Our Bookshelf

Abridged Scientific Publications from the Research Laboratories of the Eastman Kodak Company Vol. 8, 1924. Pp. 155 + vi. (Rochester, N.Y.: Eastman Kodak Co., London: Kodak, Ltd., 1925.) n.p.

THE Research Laboratories of the Eastman Kodak Company have been in full working order for about twelve years, during which time investigations have been carried on by the staff, not only on matters directly concerning the practice of photography and the manufacture of the materials and apparatus required for it, but also on various chemical and physical matters that appear at first sight to be rather remote from this subject. Time will doubtless justify this wide view of what is desirable. The results are published in numerous scientific journals as may be suitable in each case, but the papers, slightly abridged, are all brought together in the series of volumes of which this is the most recent.

This volume contains full and often lengthy abstracts of the 28 papers published last year. Many of these have already been referred to in our columns, and others are of interest only to the manufacturers and users of films for "motion pictures." Mr. F. E. Ross has dealt with the mensurational characteristics of photographic film, because film is now used for so many scientific purposes where the sensitive surface must be flexible. It appears that, generally speaking, films may show no greater distortion than glass plates, and that the different kinds of film vary somewhat. The relationship between time and intensity of illumination in photographic exposure is investigated in considerable detail and under considerably improved experimental conditions as compared with earlier work on this subject, by Messrs. L. A. Jones and E. Huse. Messrs. A. B. Corey and H. Le B. Gray, in seeking to prepare a

standard cellulose, find that by treating the product obtained as described in a previous communication with 1 per cent. acetic acid solution for two hours and subsequent washing, the ash is reduced to a very low quantity without apparent injury to the material. The reduction is stated to be "from 0.12 to 0.4 per cent." This misprint and a figure upside down at p. 16 show that more revision is desirable.

- (1) *A Laboratory Manual of the Anatomy of the Rat.* By Prof. Harrison R. Hunt. Pp. viii + 123. (New York: The Macmillan Co., 1924.) 6s. net.
- (2) *Laboratory Manual of the Foetal Pig.* By Prof. W. J. Baumgartner. Pp. xii + 57. (New York: The Macmillan Co., 1924.) 4s. 6d. net.

THESE manuals have both been written as guides to mammalian types which have been found suitable for laboratory purposes in the two universities at which the respective authors are engaged in teaching zoology. The use of the foetal pig as a type for dissection must of necessity be limited to universities and schools situated in towns, such as Chicago and Kansas, where packing plants are available as sources of supply, but the use of the rat has wider possibilities, and, for that reason, Prof. Hunt's manual will be specially welcome in Great Britain. Prof. Baumgartner's manual is modelled on Marshall and Hurst's "Practical Zoology," that is to say clear directions for dissection are picked out in italics throughout. Prof. Hunt, on the other hand, has chosen to give a more or less connected account of the various systems and organs of the rat in which instructions for dissection are given in their appropriate places, but only incidentally. The former style has so many advantages in a book designed for the use of students that one almost regrets that Prof. Hunt did not adopt it for his book, particularly as it is almost sure to have a wider field of service.

A serious defect in both books is the absence of illustrations. This is deliberate on the part of Prof. Hunt, who believes that it is better for the student to get his visual impressions from the animal itself. While appreciating this point of view, it cannot be doubted that clearly reproduced figures are a wonderful aid to dissection and are worth many pages of the most carefully written text. The authors may, perhaps, reconsider the question should further editions be called for. The addition of figures would enhance the usefulness of these two excellent manuals enormously.

The Psychology of Emotion, Morbid and Normal. By Dr. John T. MacCurdy. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xvi + 589. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1925.) 25s. net.

THE author expresses a hope that his readers may be drawn not only from psychiatrists and psychologists but also from laymen interested in psychological problems. If this hope be fulfilled, the ranks of the former will be recruited from the latter. A person who has read and understood this book and studied the work of the authorities referred to in it can scarcely be styled a layman hereafter. Should he find his interest flag, the short but excellent chapter on treatment may be relied on to revive it.

As may be surmised from these observations, the book is a comprehensive one. To fortify his thesis the author gives stimulating reviews and criticisms of the work of C. Lange and William James, of McDougall, Freud, Janet, and Morton Prince, in so far as they have concerned themselves with emotions. He includes full studies of states of anxiety, mania, stupor, depression, and perplexity, illustrated by detailed notes of some seventy cases. The thesis in question is, that emotion, both as regards its expression and its feeling-tone (or affect), is the product of mental processes occurring co-consciously, co-conscious being the term applied to unconscious mental processes in a state of activity.

The methods and reasoning by which this conclusion is arrived at cannot be compressed into a short notice, but accompanying Dr. MacCurdy along his psychological and psychiatric highways and byways is an interesting journey. On page 571 he states that "a particular grouping of words will excite a stylist pleasantly or unpleasantly." Some of the "Americanisms" in "The Psychology of Emotions" may produce the latter effect on the English stylist, but they do not detract from the value of the work as a whole.

The History of the English Novel. The Age of Romance. from the Beginnings to the Renaissance By Dr. Ernest A. Baker. Pp. 336 (London H. F. and G. Witherby, 1924.) 16s. net.

DR. BAKER takes a broader view of the origins of the English novel than is customary. He links it up not only with prose fiction of the Middle Ages, but brings it into relation with much of the material with which the student of the folk-lore and cultural history of Great Britain has to deal in the form of popular tales, legends and romances. His book, therefore, appeals to a wider public than that which is interested only in literary history. He passes beyond early prose fiction in Great Britain, touching upon its complement in France and Brittany, and goes back to early Greece, the connexion being traced through Euhemerus, the paraphrasts of Homer, and the later Greek and Latin writers of romance. To those who hold the view that the study of the folk-tale in Europe is largely a matter of literary history, Dr. Baker's investigation of sources and, perhaps in particular, of Anglo-Saxon fiction, will prove suggestive. In dealing with the Arthurian cycle, he covers ground which has been made familiar by the work of Miss Jessie Weston, Dr. Oskar Sumner, and, above all, the late Sir John Rhys; but his later chapters, dealing with other or later romances and with popular tales and *fabliaux* such as appear in the "Gesta Romanorum" and other collections, form a useful guide in a maze much of which, though not untrodden, is as yet inadequately explored. Dr. Baker's work shows wide reading and sound scholarship.

The Fats. By Prof. J. B. Leathes and Prof. H. S. Raper. (Monographs on Biochemistry.) Second edition. Pp. vii + 242 (London Longmans, Green and Co., 1925) 12s. 6d. net.

THE appearance of the second edition of this monograph, after a lapse of fifteen years, will be welcomed by all those interested in the subject. The author of the first edition, Prof. J. B. Leathes, has collaborated with Prof. H. S. Raper in the re-editing and re-writing of the present volume. The first three chapters are devoted

to the chemical and physical properties of the fats, with methods for their extraction and estimation. The remaining seven, a lengthy expansion of only a short section in the first edition, deal with their physiology and give an up-to-date and reasoned account of the parts played by them in both plant and animal tissues. The stages in their digestion, synthesis, and utilisation are fully described as far as present knowledge permits; the transport of fat in the blood is considered in detail, and a reasoned criticism of Bloor's deductions from his experimental results put forward. The last chapter deals with the rôle played by fats, apart from their function as a source of energy, in the life of the cell; they form an integral part of the structure of protoplasm, and modern work already suggests possible ways in which their molecules may be arranged therein. The work is completed by a bibliography and index.

Organic Medicaments and their Preparation By Ernest Fourneau. Authorised Translation by W. A. Silvester. Pp. x + 262 (London J. and A. Churchill, 1925.) 15s. net.

IT throws an interesting light on the working of the British educational system that although French is taught in practically every school above the elementary rank in England, it should still be thought necessary to issue English translations of French books. The French edition of M. Fourneau's book has already been reviewed in NATURE (July 15, 1922, p. 50), and the opinion there expressed that it "should find a place wherever organic chemistry is taught to advanced students" is heartily endorsed by the present writer.

Mr. Silvester has done his work well and the terseness, clarity, and precision of the original have not suffered in his handling of the text. He has taken the opportunity to add a short but well-selected bibliography, which will be useful to those unfamiliar with the subject, and notes are appended here and there throughout the text directing attention to recent developments. The French edition was issued in 1921, and it says much for M. Fourneau's skill in the selection of material that the translator has been able to bring the English edition up-to-date with so few additions of his own.

T. A. H.

Wales: an Economic Geography [By L. B. Cundall and T. Landman. Pp. x + 364. (London George Routledge and Sons, Ltd., 1925) 6s.]

THE authors have taken pains to collect and arrange their material for this geography of Wales, the first of its kind to be published. They have interpreted their subject liberally and succeeded in producing a full and accurate volume, which has the further advantage of being interesting and readable. Several of the chapters, such as those on coal and non-ferrous metals, take a wide survey of the whole subject, and might well be read by those to whom the details of Welsh geography are of minor importance. A further advantage of the book is that the historical side of industrial activity is kept well in view, so that a very clear picture is gained of the evolution of Welsh industries and towns. Statistical matter is freely used, and there are even appendices giving the trade terms used in the coal and other industries. The index is full, but might be revised in a later edition.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Conditions of Chemical Change.

PATIENCE has its limits and modesty may be overdone. I am moved to these reflections by a three-page note in the Journal of the Chemical Society to hand to-day. I am carried back forty years, to a meeting at the society, in March 1885, when a shy Oxford graduate, a worker in Mr. H. B. Dixon's laboratory, told us practically that charcoal and phosphorus could not be burnt in dry oxygen. Actually, he told us less, as he did not then go nor has he since gone beyond his facts. That, however, was the inference to be drawn from his work, taken in conjunction with that of Cowper, Dixon, Wanklyn and others, on the effect of drought in checking chemical interactions. I there and then stated what I will now venture to term the *theory* of chemical action, chary as I am always of using the word, if there be the least reason to rest more faith in honest doubt than in a creed. In a sentence, that theory is, that chemical action, of whatever kind, is essentially electrolytic: consequently, change takes place only when the potentially interacting substances constitute an electrolytic circuit: such circuit appears always to be one of three components, of which one, necessarily, is an electrolyte. I was, therefore, able to say that hydrogen and oxygen would not and could not interact; further, that even when "wetted" they would not interact, as water was not an electrolyte: only when the water was made "conducting" by the presence of a dissolved "salt," would change be possible.

Several years later, by further exact experiments, Baker demonstrated the truth of these propositions. He developed an uncanny ability in "drying" things, and proved, in numerous cases, that the conditions I had laid down were essential to the occurrence of change. Others have verified some of his observations. About three years ago, however, Coehn and Tramm questioned his work and stated that hydrogen and oxygen not only interacted, under the influence of the light from a quartz-mercury lamp, but at the same rate whether the mixture were dry or moist.

Talking the matter over with Baker, I said: "Yes, as interaction takes place in a liquid film, at the surface of the containing vessel, ultra-violet light, at a low temperature, may well have a greater effect than heating, in bringing about change. Persevere in cleaning and drying the vessel and its contents and action will be stayed."

Baker now reports, that in a quartz tube which had been dried during twelve weeks no measurable action was observed during an exposure of thirteen hours to a quartz-mercury lamp at a distance of 2 cm., although action took place in tubes less thoroughly "prepared."

Baker and I have wandered all but alone these forty years in an arid wilderness, athirst for recognition and sympathy. I feel that we must now compel this, and that we have the right to challenge all and sundry, chemists and physicists alike, to consider the grounds of their belief, if they have one. When the history of our time comes to be written, nothing will appear more striking than the strange psychology of the "scientific" worker so-called: particularly the

way in which he was captured by the wild Arrhenic speculation, more especially by Ostwald's dogmatic rulings. After all, he has but shown that he is human and dominated by the herd-instinct. Many may be called into "science," but few are chosen—to think for themselves and behave as reasoning beings. Still—

One must receive their nature in its length

And breadth, expect the weakness with the strength!

Sordello.

The issue I raise is of consequence at a time when so much importance is attached to the determination of ionisation potentials in gases and so much argument is based upon the values deduced—but no attention whatever paid to the conditions prevailing in the vessels used. Neglectful as is the chemist, the physicist is far worse: seemingly he has no conception of chemical cleanliness, and the chemist, in consequence, often takes leave to doubt not a few of his deductions. It was not always so—it was not so when chemistry was taught together with physics. Of late years, we seem to have sought how not to teach the various branches of science effectively—by teaching them singly and encouraging a crass specialisation, which is leading us to neglect and fail in solving the problems of real importance.

HENRY E. ARMSTRONG.

October 1.

Haploidy in the Male Sawfly (Tenthredinidae) and some Considerations arising therefrom.

IN 1907 Doncaster published certain statements on the gametogenesis of the common gooseberry sawfly, *Nematus ribesii* Scop. ("Gametogenesis and Fertilisation in *Nematus ribesii*," *Quart. Journ. Micro. Sci.*, vol. 51 n.s., 1907), but later, in 1909, he published a correction (*ibid.* 1909. "Gametogenesis of the Sawfly *Nematus ribesii*. A Correction." *NATURE*, Dec. 2, 1909, p. 127). Unfortunately, he never resumed the investigation, and the problem was so left that its solution demanded work *ab initio*. Since then, nothing further has been done to elucidate the question, but work done by me on the spermatogenesis of the sawfly *Pteronidea melanaspis* Htg., together with certain breeding experiments with *Pteronidea* (*Nematus*) *ribesii*, permits certain pronouncements which throw considerable light on the subject.

Doncaster's material and mine belong to the same genus,¹ and the two species behave alike sexually in that the females, by parthenogenesis, produce males only (arrhenotoky), whilst, after insemination, they produce both sexes. These reproductive habits are likewise common to a great many sawflies, and indeed, except possibly for one species only, we may lay it down as a principle that for all bisexual sawflies in which the sex-ratio is normal (about 100:100), parthenogenesis results in the production of males only.² Any conclusion concerning *P. melanaspis*, therefore, will apply most probably to all such arrhenotokous species.

The cytological results for *P. melanaspis* are:

1. The spermatogonial chromosome number is 8 (Fig. 1);
2. The spermatocyte chromosome number is also 8 (Fig. 3);
3. There are two maturation divisions in spermatogenesis, but no reduction in chromosome number (Figs. 4 and 5);

¹ *Nematus ribesii* now is called *Pteronidea ribesii* according to Enslin's classification.

² The experience of sawfly workers, notably Miss E. F. Chawner, shows that the list of arrhenotokous species will be greatly increased by further work, and indicates also that all bisexual sawflies are facultatively male-producing by parthenogenesis. Occasionally a female is produced, but this occurrence raises questions which cannot be discussed here.

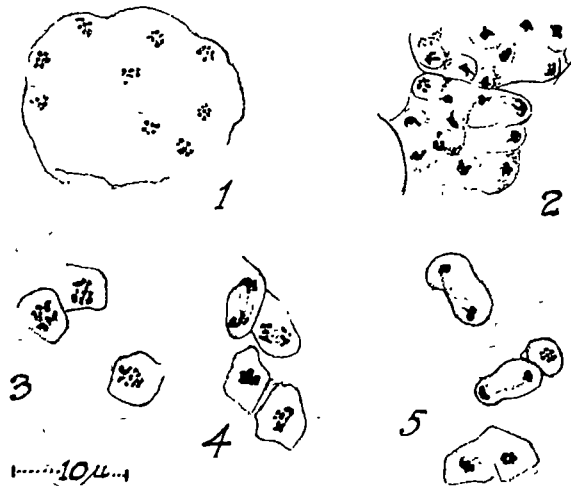
4. No abnormal methods of cell division, such as described in the spermatogenesis of the hive bee and hornet by Meves and others, have been discovered;

5. The above hold good for males obtained from parthenogenetic females and from wild larvae collected in the field.

The technique employed, fixation by Carnoy or Bouin, with the usual succeeding operations and staining by iron-haematoxylin, has given excellent results, so that the cell appearances are perfectly plain.

These findings lead to the following inferences. As the spermatogonial chromosome number of the male is 8, the somatic number is likewise 8. It follows that 8 is the haploid number, and that the male sawfly produced by parthenogenesis, in arrhenotokous species, is haploid in constitution.

Immediately, the further important question suggests itself: if the parthenogenetically produced



OUTLINE DRAWINGS ILLUSTRATING HAPLOIDY IN THE SAWFLY
PTERONIDEA MELANASPIS.

All figures drawn to same scale, using a Leitz microscope with a 10 periplanatic ocular and a $\frac{1}{2}$ oil immersion objective and a Reichert drawing apparatus. Cytoplasmic appearances and cell outlines largely lost owing to the material being fixed with Carnoy's fluid.

FIG. 1. Group of spermatogonial plates with chromosomes up to 8 in number.

FIG. 2. Spermatogonial mitosis.

FIG. 3. Chromosome plates of spermatocytes of the first order: two show 8 chromosomes and one shows 7.

FIG. 4. Equational division in spermatocytes of the first order.

FIG. 5. Plate of 8 chromosomes and phases in the division of spermatocytes of the second order.

Note, the differences in the sizes of the chromosomes and plates of the first and second spermatocytes.

sawflies of bisexual species are both haploid and male, are the males from inseminated females of such species likewise haploid and really of parthenogenetic origin also? That is, do bisexual species of sawflies follow a plan similar to that of the hive bee in which the queen, by controlling the fertilisation of the egg, produces diploid, fertilised, female-producing eggs, as well as haploid, unfertilised, male-producing eggs; or, if this be not the case, do they conform to the general rule among bisexual insects (except lepidoptera) that inseminated females give diploid and homogametic females and diploid and heterogametic males? That the former is the case is the main point of this letter.

These questions could be solved at once and directly if we knew the chromosome constitutions of such female sawflies and of the males produced by them after insemination. Unfortunately, the material from collected wild males does not provide complete information on such, but, nevertheless, an answer can still be obtained indirectly in another way, as will be seen presently, from certain breeding experiments.

The argument is as follows, and it is based on the assumption that the female sawfly is diploid and homogametic and therefore produces only one kind of germ cell—the haploid sort. This assumption is perfectly justifiable in the light of present knowledge; but its truth will be tested for the purpose of this discussion.

For example, let us suppose that the chromosome number of all parthenogenetically produced male sawflies of a given species is $n+x$, x representing the sex chromosome condition. The female, therefore, would have a diploid constitution of $2n+2x$, and would produce eggs of only one kind having the haploid chromosome number of $n+x$. Unfertilised eggs, by parthenogenesis, would of course give haploid offspring, which would be males, while the fertilised eggs would have the diploid number of $2n+2x$ restored and so yield females.

Let us now test the possibility that males produced by inseminated females have a chromosome constitution different from males produced by parthenogenesis, i.e. that there are two different kinds of males, haploids and diploids. Such diploid males, produced by the union of male and female gametes, according to present convention, would be designated $2n+x+y$ (y representing that sex chromosome possession of which determines maleness). A male would therefore produce gametes of two kinds constituted $n+x$ and $n+y$. The union of a male $n+y$ gamete with a female $n+x$ gamete would give an organism of complement $2n+x+y$, that is, a male: the union of a male $n+x$ gamete with a female $n+x$ gamete would always give an organism of $2n+2x$ complement, that is, a female. But, and here is the important point, my experiments (unpublished) with *Pteronidea* (*Nematus*) *ribesii* controvert the latter consideration, because parthenogenetically produced males, $n+x$ in constitution, mated with females, induce the production of both sexes.

Clearly, then, as the gametes from parthenogenetically produced males are all alike, the diversity in the results of pairing depends upon the female; further, this diversity can only be explained in three ways, either (1) the female controls egg fertilisation, or (2) the female is digametic, or (3) the parthenogenetically produced eggs of $n+x$ constitution are different from the $n+x$ eggs of the fertilised females. The second hypothesis is untenable for the critical reason that its consequence would be the production of two kinds of males by parthenogenesis, and we know from the above cytological results that this is not the case. Again, all female insects, except lepidoptera, are homogametic. The third hypothesis may also be dismissed, for all our knowledge to-day, and it is very considerable, on animal cytology proves that identity of chromosome constitution in eggs results in the identity of their end products, provided, of course, that the conditions of development are normal and alike.

We are left to conclude, therefore, that the inseminated female sawfly of bisexual species controls the fertilisation of its eggs, the unfertilised eggs yielding males and the fertilised eggs females.

Additional support to this thesis is obtainable from other sources, as, for example, the fact that other hymenoptera such as bees, wasps, the parasitic wasp *Hadrobracon* (Whiting) and the cynipids (*Doncaster*), behave in this way. Further, in the very species which has been cytologically examined, *P. melanaspis*, the very fact that the wild male larvae have the same chromosome constitution as the pedigree parthenogenetic males is very significant, for, even if these wild larvae were offspring of an unfertilised wild female, it is an indication that they are utilised in Nature as, certainly, similar larvae of *ribesii* are utilisable

because they have been successfully paired with females in the laboratory and offspring of both sexes have resulted.

There can be no reasonable doubt, therefore, that all sawfly males are of one kind in that they originate from unfertilised haploid eggs which may be laid by virgin females or by inseminated females.

This finding affords a clue to other problems of sawfly parthenogenesis and its evolution, but these will not be explored at this juncture, their discussion being deferred for the paper, now in preparation, which is to deal, in detail, with the matter of this letter together with other features of sawfly spermatogenesis.

It remains to make grateful acknowledgements to the British Association for a grant in aid, and to the following, all of Armstrong College: The Research Endowment Fund Committee for the provision of a Leitz Binocular Microscope, Prof. A. Meek for the facilities of his zoological laboratories, including the services of the steward, Mr. D. C. Geddes, and Dr. J. W. Heslop Harrison, who checked my cytological conclusions.

A. D. PEACOCK.

Armstrong College (University of Durham),
Newcastle-on-Tyne, September 20.

On the Advancement of Science by Published Papers.

UNDOUBTEDLY science is kept alive by teaching; and without good teaching, there can be but little discovery. Edison, for instance, when young, possessed and studied Faraday's masterly researches on electricity.

The present writer has been engaged in scientific research for eighteen years or so. He does not pretend, however, to have observed all the following rules, of the importance of which he became cognisant by degrees. The foundation of the co-operative fabric of science and scientific discovery has been built up by the work of the early "missionaries of science," when research entailed more or less of a martyrdom. It is hoped that we can pass on to posterity this edifice of science, undecayed and even embellished, now that research is a privilege and a giver of prestige. If we do not, the position of science and scientific work may deteriorate without limit.

(1) The truth, and nothing but the truth, but never the whole truth *for publication*. One must omit trivialities. Our scientific magazines are now sometimes more or less packed with never-to-be-utilised details, most of which perhaps would have better rested in the notebook. The penalty for non-observation of this rule is the, probably now imminent, cessation of publication, except in the form of abstracts.

(2) It is perhaps unethical for a research worker, as for a medical man, to advertise. Plethoric papers, pictures not absolutely necessary, repetitions in different magazines, references mainly to one's own work, and unneeded elaboration or enlargement of figures, seem to partake of the nature of advertising. The penalty for infraction is the introduction of competitive business methods into science as an ideal; instead of the co-operative aims, which have produced such good results in the past.

(3) Mere facts, however new, are often (though not always) of perceptible scientific value only when their discoverer, or some one else, has demonstrated their relations to other facts, or to a theory or hypothesis of value. If they have no such demonstrable relations, they are probably "trifling though true." The penalty is again the ending of magazine publication *in extenso*.

(4) The repetitions and confirmations of a discovery on similar or related material are of sufficient scientific interest to warrant full publication only to a certain degree of repetition. Whether this is ten or a hundred times, the point is at length reached when only the accounts of exceptions to the rule are worth full publication. The penalty is again the flooding of magazines, and the future reduction to abstract publication.

(5) The publication of a working hypothesis by one who has discovered a sufficient amount of relevant fact is welcome, and indeed almost necessary. (A working hypothesis is one that is immediately to be tested.) But a mass of untested hypotheses is readily producible; and may be aimless, except to fill space. A flood of hypotheses, which cannot be immediately tested, may be a brake on the progress of a science. Since it is easier, for many of us, to spin hypotheses than to make discoveries, the penalty for the appreciation and prestige of this form of mental exercise is the partial, or even complete, cessation of experiment.

(6) It is probably unethical to claim credit or priority for an untested hypothesis (mostly for writers in the distant past), to the prejudice of those who have borne the full burden of testing it. A writer who has published, among a number of unworkable hypotheses, one which has subsequently been used as a successful working hypothesis, does not apparently deserve to be cited. Perhaps one should not attach priority to *any* untested hypothesis, but only to true working hypotheses.

(7) It is generally recognised that, in a serious scientific paper, citations of a genuinely relevant previous work should be complete, so far as they are not known to all readers. Even excessive and pedantic citation is a fault on the right side. But surely much space might be saved by referring to standard numbered annual lists of scientific papers. The penalty for lack of citation is, of course, to leave it doubtful as to how much the writer has himself discovered. It leads also to the isolation of workers or countries. But excessive citations again overload the magazines.

(8) A form of scientific co-operation consists in the sending of separate copies of papers, in not readily accessible magazines, to other interested workers. This has now extended to all magazines, even those accessible to everybody. Stanley Hall regards it as a means of working up a personal following or constituency; in other words, it is now an advertising method. Perhaps as much as anything else, it injures the circulation of the scientific magazines.

These and other similar rules are, of course, well known to, and observed by, many experienced workers.

JOHN BELLING.

Huntington, N.Y.

The Band Spectra associated with Carbon.

IN an interesting letter to NATURE (August 8, p. 207), Prof. Birge has directed attention to a band system which I described as a "New Band System" in Proc. Roy. Soc., A, vol. 108, p. 349 (1925). More recently (NATURE, Sept. 5, p. 360) M. Baldet has written with reference to this system, pointing out that three of the six bands I recorded were measured and described by him in C.R., vol. 178, p. 1525 (1925). I should like to take the opportunity of saying that at the time of writing my paper I was not aware of this work of M. Baldet, and to him must be given the credit for the first recorded measurements of the system. At the same time, the discovery of this spectrum was first recorded by Prof. Merton and myself in Proc. Roy. Soc., A, vol. 103, p. 389 (1923),

as follows: "It should be remarked that in addition to the Comet-Tail bands which are degraded to the red, there are a number of very much fainter bands which are degraded to the violet, but are somewhat similar in appearance." Under the conditions of production in helium mixtures, this spectrum is isolated along with the comet-tail bands and negative carbon bands from all other band spectra which might conceivably have rendered the identification from this brief description uncertain.

In view of Prof. Birge's letter in *NATURE* of August 1, p. 170, which represents first steps towards the theoretical correlation of the numerous band spectra of carbon, it may not be inappropriate to record a few observations of a purely experimental character with the evidence they afford as to the origin of some of these spectra. During the last couple of years, while working with the inert gases, I have gained a detailed acquaintance with almost all the band spectra of carbon. The various conditions under which it has been found possible to isolate some spectra and eliminate others have inevitably led me to form impressions of their molecular origin.

Without wishing to open the old controversy as to the origin of the Swan bands, the following facts appear significant. The Swan bands can be isolated with exceptional brilliance in 20-50 mm. of any of the inert gases. Of helium, neon, and argon, the last named is perhaps the best in this respect. When a tube is fitted with carbon electrodes, side bulbs containing caustic potash and phosphorus pentoxide, and a palladium regulator, and filled in this way with argon, it usually shows only the Swan bands and the triplet system (*vide* Proc. Roy. Soc., A, vol. 103, p. 390). Prolonged passage of a discharge with the regulator heated so as to remove the hydrogen eliminates the triplet system and leaves the Swan bands, while further running of the tube ultimately removes the latter and there remains only the continuous spectrum of high pressure argon and perhaps the strongest lines of "red" argon. If hydrogen be now admitted through the regulator, the reversed processes can be produced, namely, first the production of the Swan bands with great brilliance, and with much hydrogen, the production of the triplet system. Tentatively, one might suggest a CH or $(CH)_2$ molecule for the former, and a molecule of greater hydrogen content, possibly CH_4 , for the latter.

I am at present engaged in a fine structure analysis of these spectra which will probably yield more definite information of the nature of the radiating molecule. The CH band, $\lambda 4315$, and associated heads can be completely isolated from all other carbon spectra under suitable conditions. In the presence of 20 to 30 mm. of argon or neon containing a little water vapour and a minute trace of a carbon impurity, the system can be produced strongly. What relationship these bands bear to the Swan and triplet systems it is at present premature to say. The fourth positive group is quite possibly of a C-H origin and appears strongly in argon under the conditions of isolation of the triplet system and the Swan bands. It was apparently not observed by M. Baldet in his thermionic bulb when filled with pure carbon-monoxide.

As regards C-O spectra, the recent work of Birge and of Blackburn appears conclusive in assigning the comet-tail bands, the associated bands previously discussed, and the negative carbon bands to a singly charged CO ion. I incline to think from experimental work that the Ångström bands, the third positive bands, and possibly the new band spectrum observed by Cameron (in course of publication) will be found to arise from a neutral CO molecule. As regards the

high pressure CO bands discovered by Fowler, both their complexity of structure and conditions of isolation (which differ so profoundly from those of the comet-tail bands) point to a more complex molecule as the emitter.

R. C. JOHNSON.
Physics Department,
Queen's University, Belfast,
September 9.

The Theory of Hearing.

IN reference to Mr. R. L. Wegel's letter to *NATURE* of September 12, p. 393, under this heading, I think it must be admitted that he and his co-workers at the Bell Telephone Laboratories have contributed a wealth of new facts bearing on the theory of hearing. It will probably be some time before these facts are fully interpreted and correlated, so that their significance in regard to the theory can be rightly appreciated.

Mr. Wegel has elaborated in detail his conception of the deformations of the basilar membrane in response to pure tones of various pitch and intensity. From careful measurements of "masking" of one tone by another, when both tones are sounded together, he estimates the spread of resonant response. The results arrived at are so surprising that the question arises whether the observed facts afford a sufficient basis for the elaborate deductions drawn from them, or whether a simpler solution cannot be found. His primary assumption is that the masking of one tone by another of greater intensity is to be explained by the submergence of the apex of the displacement produced by the masked tone in the basilar membrane by the rising slope of that due to the masking tone (*Physical Review*, February 1924, and Fig. 9, Reprint B. 58. 1).

Mr. Wegel draws the conclusion that the response to a pure tone extends the whole length of the basilar membrane, with a maximum point or apex at a level corresponding to the pitch of the tone. If we take it that the maximum displacement of a stretched string when vibrating freely does not exceed $1/100$ th of the length of the string, it would follow that for a tone of say 800 d.v. per sec. (length of basilar fibre = 0.35 mm.) the displacement of the basilar membrane along its length would have an average slope of about 1 in 5000 on one side of the apex, and 1 in 4000 on the other.

It seems almost incredible that the internal ear could instantaneously detect, and interpret as a single clearly defined pitch, a maximum point of stimulation so slightly accentuated as compared with the displacement of the rest of the membrane. But, one may ask, do Mr. Wegel's curves (Fig. 9, *loc. cit.*) actually represent the deformation to be expected, even granting the spread of resonance which he presupposes? Such a curve should be composite, and should represent the algebraical sum of the components. We should not expect the secondary tone to be entirely masked. It would give rise to a lesser secondary peak. If it caused a displacement of the basilar membrane at all, this should be appreciable, at least as an alteration of the quality of the masking tone. The ear is remarkably sensitive to alterations in the quality of sounds, either musical or unmusical. Its beats with the masking tone, though too rapid to be perceived as beats, would have the effect of doubling its intensity. As it is not perceptible, the inference is that it produces no deformation of the basilar membrane. It is suppressed, not submerged.

The phenomena of "masking" are undoubtedly puzzling, but the outstanding fact that a low tone masks one of higher pitch to a greater extent than a

higher-pitched tone masks a lower one, suggests that the explanation is to be sought in the hydrodynamics of the cochlea. It may be that the larger and slower oscillations of the cochlear fluids associated with vibrations of the basilar membrane in the apical region damp out heterorhythmic vibrations on the proximal side of the membrane over which they pass, and so suppress the higher-pitched tones. It would not follow that the harmonics, which are intermittently homorhythmic, would also be suppressed.

Mr. Wegel finds that subjective harmonics are developed in the case of pure tones of medium intensity. These subjective harmonics apparently do not affect the character of the tone heard. This would suggest that their intensity is not great relatively to that of the fundamental. The ear readily distinguishes between a pure thin tone and a rich full tone in which a number of harmonics are present. If all the "pure" tones we hear contain a whole series of overtones, what distinguishes them from the "rich" tones? That such an extensive "pattern deformation" as is represented in Fig. 1 (NATURE, September 12, p. 393) is generated by each tone which acts on the cochlea is difficult to reconcile with the extraordinary power the ear has of analysing compound musical tones, and even more with its power of instantaneously analysing, and recognising the source of, characteristic noises. This would necessitate an integration of nerve impulses within the auditory tract of almost inconceivable complexity.

G. WILKINSON.

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Physics and Metaphysics.

It is no doubt a splendid simplification to express the ninety or more chemical elements in terms of two entities, and of only two, namely, electrons and protons, but those who face squarely the problems of physics find it a large leap to follow Mr. Bertrand Russell in "What I Believe," when he states (p. 10): "Physical Science is thus approaching the stage when it will be complete, and therefore uninteresting. Given the laws governing the motions of electrons and protons, the rest is merely geography. . . ."

Those familiar with the life and writings of the late Lord Rayleigh will have come to a directly opposite conclusion, namely, this, that the region to be discovered expands continually with discovery.

The assignment to the world of a wound-up system, like a watch, consisting of protons and electrons, ignores in the first place the problem of radiation, about which we have at present two theories utterly incompatible with one another in the minds of even the finest living intellects.

The further question whether life can be interpreted, for it cannot possibly be explained, by the laws of physics alone is a wide and doubtful issue, on which the best informed are the least emphatic. It is unlikely that any great progress will be accomplished in terms of physics as known or imagined to-day.

Sufficient warning may be found in Kelvin's estimate of the age of the earth, where the logic and mathematics were faultless, so that the conclusions appeared inevitable, until a wholly new branch of physics arose, and radioactivity enabled us to realise that the initial concepts of the problem were founded on insufficient data.

Later in Mr. Russell's book (p. 22) we arrive, however, at the refreshing statements that "the philosophy of nature is one thing and the philosophy of value is another"; and again, "It is we who create value"; and yet again, "In this realm we are kings."

Values cannot be appraised in foot-pounds or calories, nor be cribbed and confined to electrons and protons. Shakespeare and Newton were sustained by food calories as other men are. The foot-pounds or ergs of work expended on "Hamlet" or the "Principia" are comparable in magnitude with those used in the efforts of an ordinary writer or worker. But how can we estimate or express the profound differences in the resulting values! These values are not material, nor can they be reduced to electrons, radiation or æther as understood or imagined by most physicists of to-day.

Another scientific heresy, not imputed to Mr. Russell, but common enough to-day, is the avowal that electrons and protons were "created" in the past, that certain "laws" were imposed upon them, and that the universe has since then been a going concern, running itself from these initial impulses alone. The idea that something created at one instant *must* continue to exist at another instant or for a period of time may be eliminated as a crude conception. The continuation of existence is as difficult to explain as is the initial existence itself.

The only solution that may be offered (and yet it is obviously no solution to us) is that time is the great illusion. We are permitted to see the moving picture film of existence unroll, but the record is, was, and will be always there. Most marvellous of all, we are allowed to take part in the production ourselves, or at least to enjoy the illusion of an active participation therein.

Statements of this kind, passing from the region of physics to metaphysics, are naturally open to more condign criticism than those to which this letter ventures to direct attention.

A. S. EVE.

McGill University,

Montreal,

September 12.

The Worth of Knowledge.

THE comments on the functions of the British Association, in the article in NATURE of September 12 on "The Worth of Knowledge," raise a consideration that should command the attention of the scientific world, whether interested in the Association or not.

We are justly proud of our science and our scientists. We can point to the departments of science, in our universities and schools, as flourishing institutions, and yet doubt whether they are fulfilling their function to the widest and best extent. Our teachers of chemistry, physics, botany, geology, and all the other branches of science, are men whose names command a world-wide respect. Further, we can agree that the time has passed when any man could include in his survey of life a complete and detailed knowledge of science as a whole. The chemist is to be congratulated if he knows all there is to be known of the chemistry of one small group of substances, and similar conditions hold for other fields of science.

Yet, with equal truth, it may be claimed that science is more than a set of separate departments of natural knowledge; and the claim that the future of humanity rests on a scientific basis can scarcely be denied. This truth and claim are to-day fairly well recognised by a wide public, which is doing its best to get as close acquaintance with scientific work as its non-technical education will permit. As Bateson wrote before the War, "I think it needs little observation of the newer civilisations to foresee that they will apply every scrap of scientific knowledge which can help, or seem to help them in their struggle, and I am good enough Selectionist to know that in that day the fate of the recalcitrant communities is sealed." True in those days, it is urgent and equally true now.

If we have a living faith in the claim, then it is a duty to preach the gospel of science far and wide. I would like to suggest that the time is ripe for the giving of life to that old subject summed up under the term Natural Science. I would like to see a department of natural science as a whole in every university and school in the land, and the growth of the idea that no man—classic, historian, linguist, or chemist—could claim to be educated who had not passed through its curriculum. I am aware that in name such departments do exist, but they cover only a number of specialist courses. The natural science for which I plead should be organised to give wide-flung views of the aims, ideals, and methods of science. They would train the individual to think and act in a scientific manner. The professorial staff should be men who, in the words of your article, could "address a public or any other audience in a manner which will command attention or stimulate interest." The research they would undertake would be the investigation of how best use, not necessarily in the material sense, could be made of scientific advances among the masses of the community.

The matter is urgent, for one has only to read the headlines of a daily paper, watch the hoarding of the kinemas, or the reading matter bought by the general public, to realise that the affairs of the world are receiving "quiet, calm deliberation" very much along Gilbert and Sullivan lines. W. F. F. SHEARCROFT.

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Peterborough.

The Arc Spectrum of Phosphorus.

KIESS (Jour. Opt. Soc. Am., July 1925) has recently shown that the arc spectrum of nitrogen consists of doublets and quartets, one very particular feature being that the lines lie either in the extreme ultra-violet or in the infra-red. There are some lines in the visible range, but they are excited only under very special circumstances.

The spectrum of the next homologue, viz. phosphorus, has been investigated by Miss Saltmarsh in Prof. A. Fowler's laboratory (*Phil. Mag.* xlvii. 874, 1924). Miss Saltmarsh has shown that the arc spectrum of phosphorus consists of doublets, and has also pointed out certain constant frequency differences.

It appears from an inspection of Miss Saltmarsh's data that the following pairs of lines having the constant frequency difference 250 form a sharp series of the type $2\pi_1$ or $2 - m\sigma$, where $2\pi_1 = 53614.8$ and $2\pi_2 = 53639.8$ approximately.

λ (Å.), Intensity.	ν .	$\Delta\nu$.	m	$m\sigma$.	Difference between Calculated and Observed Values of $m\sigma$.
2536.38 (10)	39426.3	25.4	2	14188.2	+2.8
2534.75 (8)	39451.6				
2154.77 (7)	46408.7	24.5	3	7206.6	+5.3
2153.63 (6)	46433.2				
2034.02 (7)	49163.7	25.2	4	4450.9	+8.0
2032.98 (6)	49188.9				

The more refrangible components of the pairs are fairly well represented by the formula

$$\nu = 53639.8 - \frac{R}{(m + 1.13909 - \frac{0.718054}{m})^2}$$

where $m = 2, 3, 4$ consecutively. Closer agreement

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with the observed values of ν and those calculated from the formula is obtained by taking $2\pi_2 = 53645.0$.

The difference between the terms 2σ and $3\sigma = 6982$, and this difference repeats itself in the combination of two pairs of lines having the frequency difference of 14.9 as follows:

	(8)		(6)	
	2136.79		1859.36	
$\pi_1 - 2\sigma$	46799.2	6982.8	53782.0	$\pi_1 - 3\sigma$
	15.0		14.7	
	(6)		(8)	
	2136.10		1858.85	
$\pi_2 - 2\sigma$	46814.2	6982.5	53796.7	$\pi_2 - 3\sigma$

whence $\pi_1 = 60987.4$ and $\pi_2 = 61002.4$.

Miss Saltmarsh has pointed out frequency differences of 7281 and 298, and it is seen here that 7281 is the sum of 6983 and 298, the differences being within the limits of experimental error.

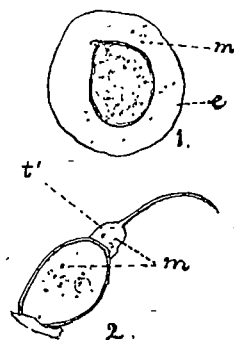
N. K. SUR.

Physics Department,
University of Allahabad,
August 15.

Formation of the Spore Tails in *Haplosporidium chitonis*.

IN *Haplosporidium chitonis* the method of formation of the spore tails, which grow to a great length after the completion of the spore coat, has always been rather difficult to understand; it seemed unlikely that the material for these tails could be provided from the interior of the spore, owing to the thickness of the spore wall, at least toward the end of their growth. On a recent *intra vitam* examination of some of these spores in Janus green, I discovered that, in the younger stages, each is surrounded by a very distinct thick cytoplasmic envelope (Fig. 1, e). The appearance at this stage gives the impression that the spore is being formed inside a cell, but the absence of nucleus outside the spore shows, of course, that this is not the case.

Certain granules can be seen in the envelope, and these appear to be similar to granules inside the spore, which I believe to be mitochondrial in nature (Figs 1



and 2, m). Both sets of granules stain slightly in Janus green. At a later stage, when the spore tails are forming, the cytoplasmic envelope, as such, has disappeared, but it has evidently gone to the formation of the tails, which are now thick and bulging at the proximal end (Fig. 2, e).

Spore formation in this protozoan has been studied by Dr. Pixell Goodrich (*Proc. Zool. Soc. Lond.*, 1915) and Prof. Debaisieux (*La Cellule*, t. xxx., 1920), and by myself in a paper still in press, but the cyto-

plasmic investments of the young spores have not been previously described. The cytoplasm of this form is very delicate, and very susceptible to adverse fixation; this must account for the disappearance of the cytoplasmic envelope in the fixed material from which most of the previous work has been done, as it would have been impossible, otherwise, to overlook such conspicuous structures.

S. D. KING.

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University of Dublin.

Dispersal of Butterflies and other Insects.

THE letter of Mr. Robert Adkin in the issue of NATURE of September 26, on the vertical upward flight of moths from the Downs near Walmer, supplies one of the desiderata required to confirm the view indicated in Mr. Felt's article in NATURE of September 5 that the upper air-currents may play an important part in the distribution of flying insects. I have myself long expected that the dispersal of insects would ultimately attract the attention of the meteorologist, and Dr. Simpson's British Association address, which immediately precedes Mr. Felt's article, reads appositely beside Mr. Felt's appeal for the aid of convectional currents arising from heated surfaces in assisting insects to gain the upper air-strata. But in this connexion we must not forget that mountaineers have long exercised their brains over the problem of insects on high mountain tops. Whymper in particular, in his work on the equatorial Andes, dealt with this subject, and he quotes Humboldt and Bonpland as showing that insects are transported into the upper regions of the atmosphere (16,000 to 19,000 feet), and adds that the transportation of insects by ascending air-currents has occasionally been observed in operation. One such set of observations is noted by Mr. Felt when he writes, "Collectors on some of the high mountains, such as Mount Washington, have taken insects which are distinctly southern or south-western in habitat, probably carried there by the upper air-currents and dropped upon these cooler mountain tops."

After reading about the recent developments of our knowledge of the upper air-strata, I am inclined more and more to regard the trans-oceanic distribution of insects as carried out mainly in the upper air. My difficulty would be in assuming that insects are hardy enough to withstand the strain of upper-air conditions. When I was camped out on the top of Mauna Loa (13,600 feet) in Hawaii in 1897, this aspect of the question was brought home to me in a striking fashion. The lava rock and beds of cinders outside my tent were strewn with butterfly wings cast off by butterflies which had been brought by the trade-wind current up the mountain slopes from the forests below. The air was intensely dry and extremely electrical, producing distressing physiological effects, which, together with the freezing up of everything liquid in my tent, made life for a man scarcely bearable. To these conditions all the butterflies succumbed that reached the top of Mauna Loa.¹ There their wings lay around me in their hundreds. Mr. Felt should in this experience of mine find the greatest difficulty in accepting the 2000-mile air-trip postulated for Californian insects in reaching the Hawaiian Islands, and perhaps the meteorologist would decline taking on his shoulders the responsibility of Insect Distribution in the upper air.

Mr. Felt suggests the possibility of there being

¹ My observations on Mauna Loa were given in my book on "Plant Dispersal in the Pacific" (1906), and were alluded to in NATURE towards the close of 1897 (vol. 57, p. 20).

sometimes a condensation of insect life at particular levels, due to atmospheric disturbances, and that their instinctive efforts to save themselves may result in the great invasions of insects noticed in different localities. This seems likely enough. Perhaps some air-man on the wing at high altitudes has flown through a bank of insects in the clouds, held there by unfavourable conditions in the air-strata above and below.

H. B. GUPPY.

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Fowey, Cornwall,
September 27.

Locomotion of the Sunfish.

THE mode of swimming of the sunfish (Mola), which I have had many opportunities of observing at close quarters, is unusual, perhaps unique, but easy to comprehend as compared with that of other fishes. The long dorsal and ventral fins are stiffened on their anterior and flexible on their posterior edges, like the wings of insects. The action of great masses of muscle at their bases causes them to strike the water laterally, first to the right and then to the left, the two fins striking simultaneously towards the same side like wings, but in a horizontal instead of a vertical direction (Fig. 1, B). Owing to the differences

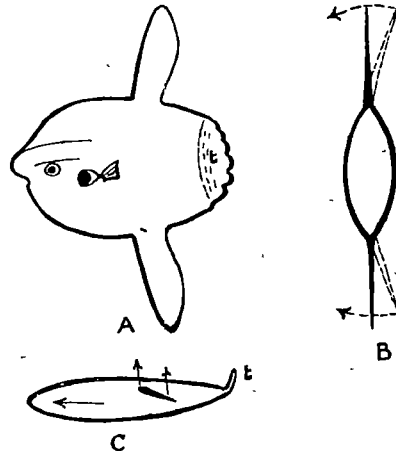


FIG. 1.—A, side view of Mola; B, transverse section in region of fins; C, diagram of Mola seen from above with fins striking to the right.

of flexibility over the surfaces of the fins, their planes are twisted in the act of striking so as to give a forward thrust (Fig. 1, C). Of course, since they strike sideways, there is also a lateral thrust, but this is correlated with the flattened shape of the body, which, acting like the keel of a sailing boat, resists lateral displacement.

The body of the fish is rigid except for the "tail" (*t* in figures), which acts exactly like the rudder of a ship. Fig. 1, C, shows it hard a'port; I have seen it held over like this as the fish turned in a large circle to the right. Since the backwash from the fins does not strike the rudder, one would expect the sunfish to resemble a paddle steamer (as opposed to a screw steamer) in not being able to turn before getting a fair amount of headway on. It is perhaps to provide an auxiliary steering apparatus that the respiratory arrangements are modified so that a very powerful jet of water can be squirted backwards from under either gill cover at will.

G. C. C. DAMANT.

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September 16.

The Physiological Basis of Athletic Records.¹

By Prof. A. V. HILL, F.R.S.

FATIGUE AS THE DETERMINING FACTOR.

AN important and interesting problem for any young athlete is presented by the question: "How fast can I run some given distance?" The maximum speed at which a given distance can be covered is known to vary largely with the distance. What are the factors determining the variation of speed with distance? How far, knowing a man's best times at two distances, can one interpolate between them for an intermediate distance, or extrapolate for a distance greater or less?

Obviously the answer to such questions depends upon the factor which in general terms we designate fatigue.

similar factors, which may affect an individual long before his muscular system has given out. Of these three forms of fatigue the first one only is as yet susceptible of exact measurement and description. The second type may quite possibly come within the range of experiment at no distant date. The third type is still so indefinite and complex that one cannot hope at present to define it accurately and to measure it. Undoubtedly, however, all these types of what we call "fatigue" influence—indeed, determine—the results which are to be presented.

In Fig. 1 all the important world's records are pre-

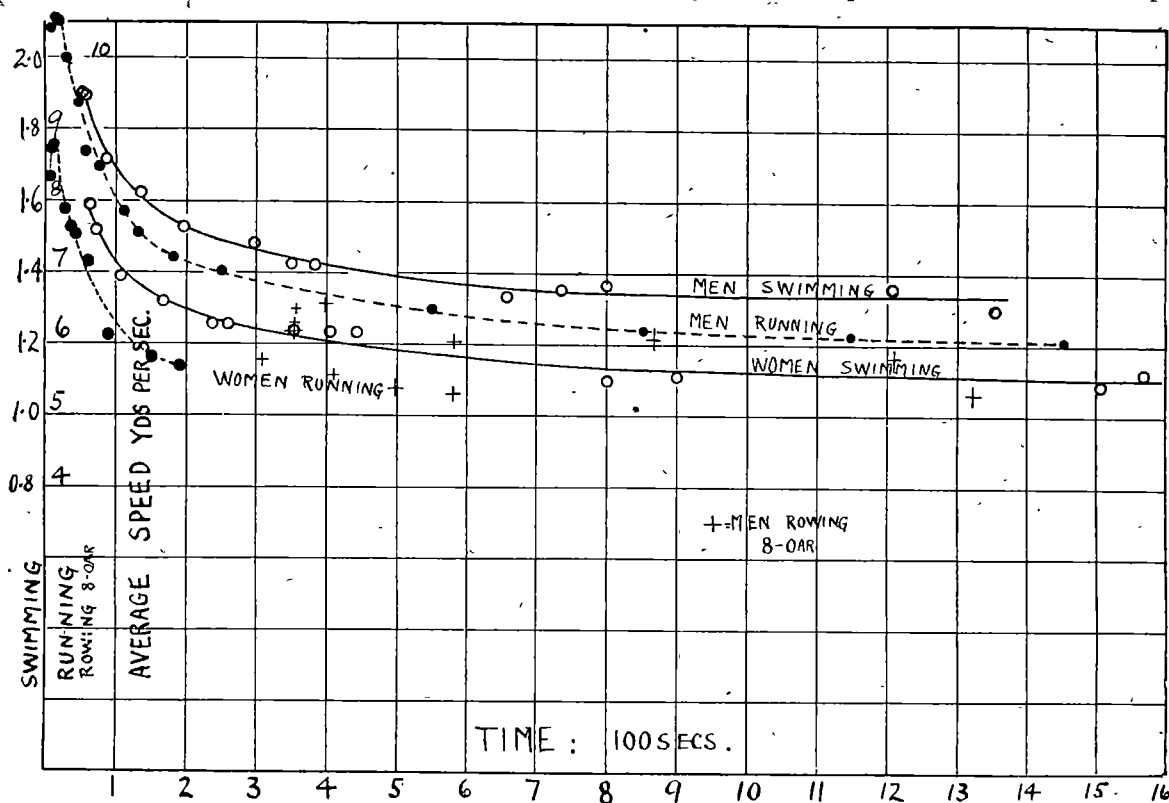


Fig. 1.—World's records for men and women swimming and running: average speed in yards per second against time in seconds. Note.—The scale for swimming is five times as great as for running. The observations for men rowing an eight-oar boat are on the same scale as running and are referred to later in the text.

Fatigue, however, is a very indefinite and inexact expression; it is necessary to define it quantitatively before we can employ it in a quantitative discussion such as this. There are many varieties of fatigue, but of these only a few concern us now. There is that which results in a short time from extremely violent effort: this type is fairly well understood; there is the fatigue, which may be called exhaustion, which overcomes the body when an effort of more moderate intensity is continued for a long time. Both of these may be defined as muscular. Then there is the kind which we may describe as due to wear-and-tear of the body as a whole, to blisters, soreness, stiffness, nervous exhaustion, metabolic changes and disturbances, sleeplessness, and

sented, average speed against time, for men and women running and for men and women swimming. The crosses representing men rowing in an eight-oar boat will be discussed later. It is obvious in all four cases that we are dealing with the same phenomena, a very high speed maintainable for short times, a speed rapidly decreasing as the time is increased and attaining practically a constant value after about 12 minutes. There are no trustworthy records, in the case of swimming, for times of less than about 50 seconds, so that the curves cannot be continued back so far as those for running. There can, however, be no doubt that the curves for running and swimming are essentially similar to one another and must depend upon the same factors. The phenomena shown in Fig 1 are susceptible of a fairly exact discussion.

¹ From the presidential address delivered at Southampton on August 31 before Section I (Physiology) of the British Association.

OXYGEN INTAKE, OXYGEN REQUIREMENT,
AND OXYGEN DEBT.

In recent papers my colleagues and I have tried to emphasise the importance of a clear distinction between the oxygen intake and the oxygen requirement of any given type and speed of muscular effort. When exercise commences, the oxygen intake rises from a low value characteristic of rest to a high value characteristic of the effort undertaken. This rise occupies a period of about 2 minutes; it is nearly complete in 90 seconds. The oxygen used by the body is a measure of the amount of energy expended: one litre of oxygen consumed means about five calories of energy liberated, enough to warm 5 litres of water 1° C.—expressed in mechanical energy, enough to raise about 1 ton 7 feet into the air.

It has been established, however, that the oxygen need not necessarily be used during the exertion itself.

The muscles have a mechanism, depending upon the formation of lactic acid in them, by which a large amount of the oxidation may be put off to a time after the exercise has ended. The recovery process, so called, requires this delayed oxidation: it is just as important to the muscle as recharging to an electrical accumulator. The degree, however, to which the body is able to "run into debt" for oxygen, to carry on not on present but on future supplies, is limited. When an "oxygen debt" of about 15 litres has been incurred the body becomes incapable of further effort: it is completely fatigued. In anything but the shortest races our record-breaking athlete should finish with something near a maximum oxygen debt, otherwise he has not employed all his available power, he has not done himself full justice. The maximum effort, therefore, which he can exert over a given interval depends upon the amount of energy available for him, upon (a) his maximum oxygen intake (that is, his income), and (b) his maximum oxygen debt (that is, the degree to which he is able to overdraw his account). These maxima are fairly well established for the case of athletic men of average size—about 4 litres per minute for the one, about 15 litres or rather more for the other.

It is possible for a man to make an effort far in excess of any contemporary supply of oxygen. This effort will require oxygen afterwards, and the total oxygen needed per minute to maintain the exercise can be measured. It is what we call the "oxygen requirement" characteristic of the effort involved. Now, experiments have shown (see Fig. 2) that the oxygen requirement varies very largely with the speed: it increases far more rapidly than the speed, more like the second, third, or even some higher power of the speed, so that high speeds and intense efforts are very wasteful. These facts enable us approximately to deduce the general form of Fig. 1. . . .

It is obvious, however, that we must not pursue the

argument too far. A man cannot exhaust himself completely in a 100 or a 200 yards race: a quarter-mile, in the case of a first-class sprinter, is enough, or almost enough, to produce complete inability to make any immediate further effort. We have found an oxygen debt of 10 litres even after a quarter-mile in 55 seconds, and one of 15 litres after 300 yards at top speed. It is obvious, therefore, that we cannot pursue our argument below times of about 30 to 40 seconds, and that the maximum speed for very short distances is limited by quite other factors than the amount of energy available. Neither can the argument be applied to very long races, where other types of exhaustion set in.

COMPARISON OF MEN AND WOMEN; SWIMMING
AND RUNNING.

There are certain characteristics of these curves which are of interest. In the first place, those for men and

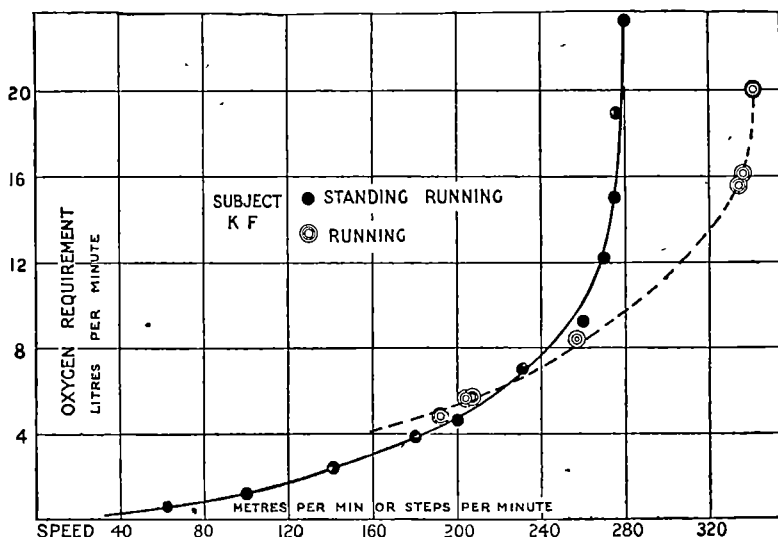


Fig. 2.—Observations of oxygen requirement of K.F. running and standing-running at various speeds. Horizontally, speed: running, metres per minute; standing-running, steps per minute. Vertically, oxygen requirement per minute, litres.

women are almost precisely similar. For a given time of swimming the maximum speed for a woman appears, throughout the curves, to be almost exactly 84 to 85 per cent. of that for a man. If we assume what is roughly true, that the energy expenditure rises approximately as the square of the speed, we may conclude that a woman swimming is able to exert, per kilogram of body weight, about 72 per cent. of the power expended by a man. Women are well adapted to swimming: their skill in swimming is, presumably just as great as that of men; the difference in the maximum speed for any given time can be a matter only of the amount of power available.

In running, the same type of comparison may be made, and it is found that a woman running is able to liberate in a given time only about 62 per cent. of the energy expendible by a man of the same weight. It is probable that this ratio as determined by swimming and by running respectively is really the same in either case, and that the apparent difference depends upon an inexactness in the simple laws assumed. It would seem fair to take the mean of these two values, 67 per cent., as the ratio of the amount of energy expendible by

a woman in a given time as compared with that by a man of the same weight. It would be of great interest—and quite simple—to test this deduction by direct experiment on women athletes.

THE CHARACTERISTIC OXYGEN-REQUIREMENT-SPEED CURVE AND SKILL.

The curves given in Fig. 2 define the economy with which movements are carried out. By such means can be shown the amount of energy required, in terms of oxygen used, in order, say, to run or swim for a minute at any given speed. The curves will vary largely from one individual to another. It is obvious, however, that such a curve must exist for any person performing any kind of continuous muscular exercise. In it we have a characteristic of that given individual for that particular form of work.

Some people are much more skilled than others. To a large degree, of course, the skill and grace associated with athletic prowess is natural and inborn; to a large degree, however, it can be produced by training and

bicycling. It is obvious at once that neither of these two curves falls anything like so rapidly as does that of a running man; fatigue does not so soon set in; the amount of energy expended at the highest speed must be much less than in a running man. This conclusion, indeed, is obvious to any one who has tried to ride a bicycle fast. It is impossible to exhaust oneself rapidly on a bicycle. The curve for horse-running is almost parallel to that for bicycling; presumably, therefore, the movements of a horse are so arranged that the extreme violence of effort possible in a human "sprinter" is unattainable.

SHORT AND LONG RACES.

Let us pass now to a consideration of the last diagram, Fig. 4. Average speed in a race is plotted against the logarithm of the time occupied in it, the logarithm being employed for the purpose of including all records from 75 yards to 100 miles in the same picture. Fig. 4 presents the data of athletics perhaps more clearly than any other. The initial rise of the

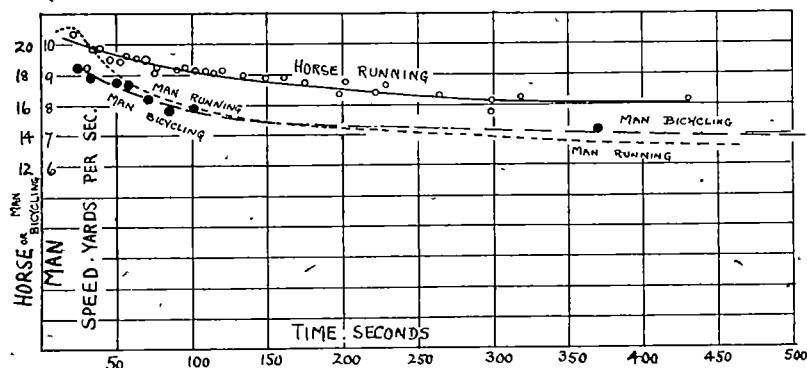


FIG. 3.—Records for horse running and man bicycling; dotted curve for comparison, man running, taken from Fig. 1. Horizontally, time in seconds, vertically, average speed yards per second. Note.—The horse and the man bicycling are shown on half the scale of the man running. The records for bicycling are the unpaced professional records against time. The records for horses were made in America.

breeding. All the movements required in the violent forms of muscular exertion here discussed are rapid ones, far too rapid to be directly and continuously subject to the conscious intelligence: they are largely, indeed mainly, reflex, set going by the will, but maintained by the interplay of proprioceptive nervous system and motor apparatus.

The forms of the characteristic curves of Fig. 2 depend upon the skill of the subject in ordering his movements, just as the "miles per gallon" of the motor-car depends upon the skill of those who designed and adjusted its timing gear and its magneto. Given incorrect adjustment due to lack of skill, given imperfect timing of the several parts of the mechanism, given unnecessary movement and vibration, the whole system will be inefficient. Fundamentally the teaching of athletics for anything but the shortest distances consists in training the performer to lower the level of his characteristic curve, to carry out the same movements at a given speed for a smaller expenditure of energy.

BICYCLING AND HORSE-RUNNING.

Not all forms of muscular exertion are so violent, involve so great an expenditure of energy, when carried out at the highest speed, as running and swimming. In Fig. 3 are two examples of this fact, horse-running and

one mile, and six miles. In Fig. 1 we saw that the speed fell to what seemed to be practically a constant level towards the right of the diagram: this fall represents the initial factor in fatigue. On the logarithmic scale, however, where the longer times are compressed together, the curve continues to fall throughout its length. This later fall is due to factors quite different from those discussed above. Consideration merely of oxygen intake and oxygen debt will not suffice to explain the continued fall of the curve. Actually the curve beyond 10 miles seems to some degree doubtful. Apparently the same extent of effort has not been lavished on the longer records: the greatest athletes have confined themselves to distances not greater than 10 miles. The most probable continuation of the running curve would seem to be somewhere between the lines B and C.

The continued fall in the curve, as the effort is prolonged, is probably due either to the exhaustion of the material of the muscle, or to the incidental disturbances which may make a man stop before his muscular system has reached its limit. A man of average size running in a race must expend about 300 gm. of glycogen per hour; perhaps a half of this may be replaced by its equivalent of fat. After a very few hours, therefore, the whole glycogen supply of his body will be

exhausted. The body, however, does not readily use fat alone as a source of energy: disturbances may arise in the metabolism; it will be necessary to feed a man with carbohydrate as the effort continues. Such feeding will be followed by digestion; disturbances of digestion may occur—other reactions may ensue.

The women's curve, so far as it goes, is very similar to the men's. An enterprising woman athlete who wants to break a record should avoid the 300 metres; she would be well advised to try the 500 metres. It would be very interesting to have an intermediate point between 100 and 220 yards.

ROWING.

There are only a few records available, and those lying between rather narrow limits, for the case of rowing. Taking the case of an eight-oar boat, the most reliable of the data have been plotted in Fig. 1 on the same scale as the running, on five times the scale of the swimming. The observed points, shown by crosses, are somewhat scattered. So far as they go, a mean curve through them would lie practically along the curve for women swimming, but, of course, on five times the scale. The interesting part of the curve to the left

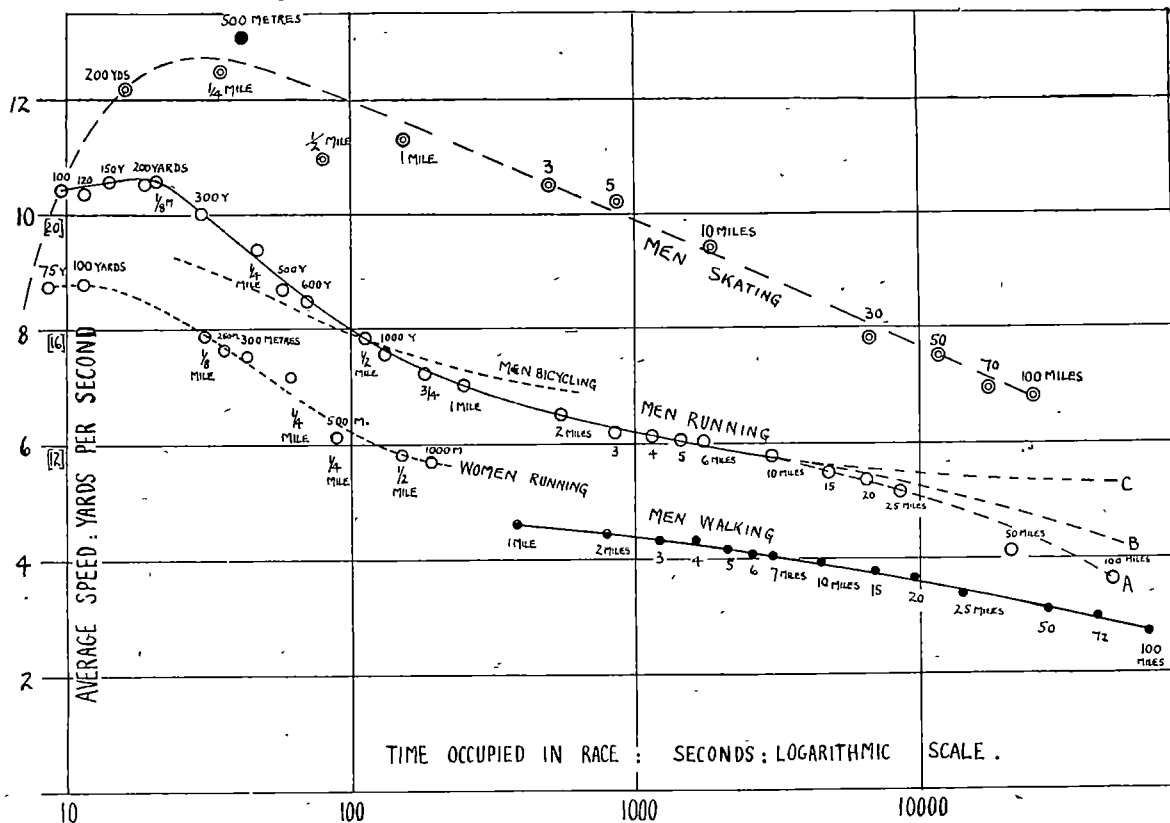


FIG. 4.—Records for men skating, bicycling, running and walking, and for women running. Horizontally, logarithm of time occupied in race, vertically, average speed in yards per second. The same scale is used throughout, except for bicycling, where half the scale is employed, as shown in square brackets. The curve for men running appears to be somewhat doubtful beyond 10 or 15 miles, and three alternative curves are shown by broken lines.

BICYCLING AND WALKING.

As before, the curve for men bicycling, which is drawn on twice the scale vertically of the running curves, is far less steep than they are. The conclusion from this was emphasised above. The walking curve is interesting—it is approximately straight. Physiologically speaking, there is not much interest in the shortest walking races, since here walking is artificial and extremely laborious; running at a considerably higher speed is much more easy. For longer distances, however, say from 10 miles onwards, we have probably in walking the most trustworthy data available for long-continued muscular effort. If we wish to study the exhaustion produced by exercise of long duration, walking-men may well provide the best subjects for our experiments.

is lacking: it is obviously impossible to make observations on an eight-oar boat for periods of 20 seconds; starting inertia is too great and no result of any value could be obtained.

In rowing the movements are slow: in an eight-oar boat, from 30 to 40 strokes per minute. According to observations by Lupton and myself, the maximum efficiency of human muscular movement is obtained at speeds of about one maximal movement per second. In rowing, experience and tradition alike suggest that such a speed is about the optimum. In an eight-oar boat the recovery takes almost as long as the stroke, both occupying about one second. It is of interest how practical experience has gradually evolved a speed of movement which is almost exactly what a physiologist might have predicted as the most efficient. At

a stroke of about 32 per minute the mechanical efficiency is apparently near its maximum.

An enormous amount of work has to be done in propelling a boat at speeds like 10 to 12 miles per hour. According to Henderson, each member of the crew of an eight-oar boat must exert about 0.6 of a horse-power. Clearly, if this enormous amount of external work is to be done, it must be accomplished by working under efficient conditions: those conditions necessitate a stroke of a particular frequency; only when the race is very short is it permissible, in order to obtain a greater output, to work less efficiently by adopting a more rapid stroke. The stroke may rise to 40 per minute for a short distance: in such an effort the oxygen debt is accumulating rapidly and exhaustion will soon set in. The amount of work, moreover, will not be proportionately greater, probably only slightly greater, than at the lower frequency. The conditions which determine the speed of movement, the "viscous-elastic" properties of muscle, are what ultimately decide the length of the oars and the speed of movement in a racing-boat.

WASTEFULNESS OF HIGH SPEEDS.

This last discussion leads us to the question of what determines the great wastefulness of the higher speeds. Why, returning to Fig. 2, does a speed of 280 steps per minute require 24 litres of oxygen per minute, while a speed of 240 steps per minute requires only eight litres of oxygen? The answer depends upon the variation of external work with speed of muscular movement. In a series of recent papers it has been shown that in a maximal muscular movement the external work decreases in a linear manner as the speed of shortening increases. At sufficiently high speeds of shortening no external work at all can be performed.

In most of these athletic exercises, apart from the case of rowing, a large proportion of the mechanical work is used in overcoming the viscous resistance of the muscles themselves. At high speeds of running only a small fraction of the mechanical energy of the muscles is available to propel the body, once the initial inertia has been overcome. The work is absorbed by internal friction, or by those molecular changes which, when the muscle is shortening rapidly, cause its tension to fall off. When working against an external resistance, as in rowing, there is an optimum speed. If an effort is to be long continued it must be made at a speed not far from the optimum. When, however, the whole of the resistance to movement is internal, as in running,

there is no optimum speed: the expense of the movement increases continually as the speed goes up; the faster we move, the greater relatively the price: our footsteps are dogged by the viscous-elastic properties of muscle, which prevent us from moving too fast, which save us from breaking ourselves while we are attempting to break a record.

JUMPING.

One final point may be worthy of mention—this time connected with high-jumping and long-jumping. Recently I made a series of observations, with a stop-watch reading to 0.02 second, of the times occupied by a number of high-jumpers from the moment they left the ground to the moment they reached the ground again. With men jumping about 5 feet the time averaged about 0.80 second. Calculating from the formula

$$S = \frac{1}{2}gt^2,$$

where t is half the total time of flight, the distance through which the centre of gravity of the body was raised must have been about 2.5 feet. The men competing must have had an original height of their centre of gravity of about 2.9 feet. Thus, in the high-jump, their centres of gravity went about 5.4 feet high into the air. The world's record high-jump is 6.61 feet, the centre of gravity of the performer being presumably about 3 feet high at rest. He raises it therefore 3.61 feet into the air, from which we may calculate that the whole time occupied in the jump is about 0.96 second. All the characteristics of the proprioceptive system must be evoked in their highest degree in carrying out such a skilled, rapid, and yet violent movement in so short a time.

In long-jumping, it is well known that success consists in learning to jump high. The world's record long-jump is 25.48 feet. With the check provided by the vertical impulse in the last step we cannot well imagine the horizontal velocity to be greater, at this moment, than that of 100 yards completed in 10 seconds; that is, than 30 feet per second. Let us assume this value, then the performer remains in the air for 0.85 second: hence we may calculate that the vertical distance covered is about 2.9 feet. Assuming the centre of gravity of the subject to have been originally 3 feet high, this means that it must have reached a height 5.9 feet in the air, enough, in a high-jump, to enable its owner to clear 5.9 feet. It is interesting to find that the simple laws of mechanics emphasise so strongly the precepts of the athletic trainer.

A High-frequency Induction Furnace for making Alloys.

A PAPER on a high-frequency induction furnace for making alloys was presented by Mr. D. F. Campbell at the autumn meeting of the Iron and Steel Institute held in Birmingham on September 10. The early work in this field was carried out at Princetown University by Dr. Northrup, whose investigations of the physical laws governing induction from high-frequency equipment led to the evolution of the first metal-melting furnaces. As Mr. Campbell points out, low-frequency induction furnaces have been known for forty years, and twenty years ago it seemed possible that they would, to a large extent, replace the crucible

process for high-grade steel making. This possibility, however, has for a variety of reasons not been fulfilled. Inductive heating has, however, found wide application in the non-ferrous trade in furnaces having a vertical slot worked on normal commercial frequencies. These furnaces have the disadvantage of requiring an iron core, in consequence of which the molten metal is contained in small channels surrounding the iron core as well as in the main bath of the furnace. This involves much wear and tear of the refractory material.

In the case of high-frequency heating the conditions

are quite otherwise. The container is a cylindrical vessel holding the maximum of metal with a minimum of radiating surface and refractory material exposed to corrosive action. The heat is generated in the charge to be melted and consequently there is no loss in the passage through refractory containers as in crucible furnaces. The high-frequency furnace has an immensely steep heat-gradient between the molten metal and the outside of the furnace. The furnace described by Mr. Campbell consists merely of a container or crucible placed inside a flat cylindrical coil. The intermediate space, about one inch in diameter, is filled with zircon or other insulating material contained in a silica or mica sleeve. The crucible need not be more than half an inch thick. As the heat is generated within the metal, the temperature of the crucible is very much lower than that of the metal itself. Consequently, reactions between the metal and crucible walls are reduced to a minimum, and crucibles of material quite inadmissible in other high temperature processes stand up well in the furnace.

According to the author, an ordinary clay crucible, such as is used for gold assays, will make from 10 to 30 heats of nickel-iron alloys containing less than 0.02 per cent. of carbon. A high-frequency furnace mixes the metal very thoroughly. The surface of the molten metal is pronouncedly convex, owing to the violent upward current at the centre of the liquid mass. This is a great advantage for the manufacturer of alloys made from metals which do not mix readily. The frequencies used may be termed "high" or "medium" and have varied from 20,000 to 400 periods per second, the lower figures being applicable to the larger furnaces for melting nickel silver and similar alloys. Furnaces of a capacity of 600 lb. are now working on certain nickel alloys. In cases where it is essential that the alloys should contain a minimum

of carbon, it looks as though they will have a great field of application. The author states that the capital cost of equipment is high, but that some cheapening ought to be obtained in the future.

At present the principal application of this method of heating is in the preparation of alloys which are used for the manufacture of continuously loaded cables. Indeed, the discovery of the two principal alloys now used, namely, permalloy and mumetal, was made possible by the use of a high-frequency furnace. These alloys are composed principally of nickel and iron with small percentages of other metals, and the lowest possible amount of carbon. By the use of this alloy the speed of signalling by long-distance submarine cables has been raised from a maximum of 300 letters per minute for that type of cable to 1800 for a continuously loaded cable. This performance was obtained between the Azores and the United States. An installation recently completed near Birmingham has by far the largest melting capacity of any high-frequency metallurgical works yet erected. The equipment consists of forty-two small converter units of from 35 to 40 kilo-volt ampere capacity fitted with furnaces capable of melting 20 lb of nickel-iron alloys of the highest purity in from 40 to 45 minutes.

Great advantages are also being found for furnaces of this type used in research, owing to the speed with which small heats can be made either *in vacuo* or in air. The author states that in one instance where an investigation was being made into the properties of a series of alloys with a relatively high melting-point, twenty 2-lb. heats were made in eight hours. For some time past the Metallurgical Department of the National Physical Laboratory has included in its equipment a furnace of this type, and great use is being made of it in the preparation of an exceptionally pure series of iron alloys.

Obituary.

PROF. H. H. HILDEBRANDSSON.

THE death of Hugo Hildebrand Hildebrandsson at Upsala on July 29 of this year, at the advanced age of eighty-seven years, marks the passing of a meteorologist of exceptional character. He was secretary of the International Meteorological Committee in succession to R. H. Scott from 1900 until 1907, when he himself retired from the direction of the Institute of the University of Upsala, at which he was the first professor of meteorology, to be succeeded by his son-in-law, F. Åkerblom, the present professor. His name is known throughout the meteorological world for his activity in connexion with the study of clouds in all parts of the world, which culminated in the "International Cloud Year" 1896-97, and found further expression in the "International Cloud Atlas" published mainly under his guidance in 1896, with a new edition in 1910.

Hildebrandsson was scarcely less well known for his researches on "centres of action of the atmosphere" in the Transactions of the Royal Swedish Academy, and still further for his collaboration with Teisserenc de Bort, not only in the investigation of the upper air, but also in the publication through Gauthier-Villars of "Les Bases de la météorologie dynamique: Historique

—État de nos connaissances," a truly magnificent work left unfinished by the untimely death of Teisserenc de Bort. For the text of that work Hildebrandsson was mainly responsible, though it expressed the joint ambition of both to have full regard to the unity of the atmospheric circulation and treat meteorology as a world study. With that ambition, in 1907, the two friends became the bureau of an International Commission for a *réseau mondial*. Teisserenc de Bort wished it to be telegraphic, but the expense at that time being prohibitive, Hildebrandsson pressed the claims of a climatological *réseau*. The Commission still exists, with Dr. Simpson as president, and in the development of wireless telegraphy Teisserenc de Bort's ambition will be realised.

It was in his attitude towards world meteorology and a *réseau mondial* that Hildebrandsson displayed his special characteristic. Most meteorologists are content to write commentaries on some point or subject of physical or geographical importance in the structure or circulation of the atmosphere; Hildebrandsson wanted to make out the connected story of the atmospheric circulation before embarking upon a commentary. He recognised that writing commentaries runs great risk of marking time so long as

the author has only nebulous ideas about the text upon which he comments, and that the elaboration of the text for meteorology is an inductive enterprise of the most embarrassing character. At the same time, he knew that there is no short cut: no ingenuity can produce a substitute for the inductive co-ordination of the real facts of the circulation. Hence the Meteorological Institute at Upsala an academic establishment with no responsibility for any *réseau* of stations, became a centre of illumination and learning for the Scandinavian countries, and typical of a college for the meteorology of the globe, a nucleus round which effective knowledge of meteorology may crystallise with a rapidity as surprising and as beautiful as the laboratory experiment which furnishes the analogy.

Like some other meteorologists, Hildebrandsson began as a physicist and he remained a physicist to the end; but it is clear from the records of his work that he recognised the true basis of the science of meteorology to be neither physics nor geography alone, but a combination of the two

NAPIER SHAW.

MR. THOMAS STEEL.

By the death of Mr Thomas Steel in Sydney on August 17 last, Australia has lost an enthusiastic and observant naturalist. His publications include descriptions of Australian land planarians and notes on their habits. Mr. Steel was born in Glasgow in 1858, and after training as a chemist entered the service of a sugar refinery in Greenock. In 1882 he was appointed chemist to the Colonial Sugar Refining Company of Sydney. Much of his spare time was devoted to the study of the fauna of New South Wales and of Victoria, and he accumulated a large collection of excellently preserved specimens, especially of land planarians and

Peripatus, many of which he gave to the Australian Museum and others to his zoological friends in Great Britain. Mr Steel was a prominent member of the Linnean Society of New South Wales, and was president in the years 1905-7.

PROF S J. JOHNSTON.

PROF S J JOHNSTON has not long survived his former chief, Prof. W. A. Haswell. Johnston joined the staff of the Department of Zoology in the University of Sydney in 1906, and soon became known as a stimulating lecturer and demonstrator in the practical classes. His memoir on the Trematodes of Australian frogs gained for him the doctor's degree in 1912. On the retirement of Prof. Haswell in 1918, Johnston was appointed to succeed him, but his health soon failed and he resigned at the beginning of 1922. He died on July 16.

WE regret to announce the following deaths:

Prof H Bekker, secretary of the Natural History Society (Rerum Naturae Investigatorum Societas), at the University of Tartu (Dorpat) in Estonia.

Dewan Bahadur Lewis Dominic Swamikannu Pillai, president of the Madras Legislative Council, and author of "An Indian Ephemeris, A.D. 700 to A.D. 1799," and other works on Indian calendar systems and chronology, at sixty years of age.

Capt H Riall Sankey, past-president of the Institution of Mechanical Engineers, an authority upon steam and gas engine problems, and consulting engineer of the Marconi Wireless Telegraph Co., Ltd., on October 3, in his seventy-second year.

Sir William Schlich, F.R.S., formerly professor of forestry, University of Oxford, and inspector-general of forests, Government of India, on September 27, at eighty-five years of age.

Current Topics and Events.

CONGRATULATIONS are due to Prof. W. Carmichael M'Intosh, F.R.S., emeritus professor of natural history in the University of St. Andrews, who celebrates his eighty-seventh birthday this week, having been born on October 10, 1838. Time has dealt kindly with this veteran of science, as all must have noticed who, in London, this summer, came in contact with his engaging and breezy personality. A pioneer of research in fishery problems, he was the first to found a marine biological station in Great Britain. Elected a fellow of the Royal Society in 1877, Prof. M'Intosh received a Royal medal in 1899, at the hands of Lord Lister, then president, in recognition of his labours as a zoologist. Earlier (1869) the Royal Society of Edinburgh awarded him its Neill prize for his paper "On the Structure of the British Nemertean, and on some New British Annelids." President of the Section of Biology of the British Association, Aberdeen meeting, 1885, he discoursed at some length on the phosphorescence of marine animals. Last year Prof. M'Intosh received the Linnean medal allotted especially to mark the Linnean Society's admiration for the single-hearted devotion and unremitting industry with which he had engaged in the study of the animal inhabitants of the sea. Oppor-

tunity was taken to congratulate him on the completion of his great "Monograph of the British Marine Annelids," published by the Ray Society. We understand that Prof. M'Intosh has been a fellow of the Linnean Society for sixty-two years, whilst being second in seniority amongst the whole body of fellows, in point of election.

NEITHER students nor staffs have much enthusiasm for the speech-making incidental to the formal occasions of academic bodies, but few of us, happily, are really immune from the infection of ideas, and the flood of formal oratory serves a variety of purposes, mostly good. The London Medical Schools have just experienced such a flood on the opening of their winter session. Prof. Buckmaster, at St. George's, referred to his own student days half a century ago, when the microscope was not of much service to medicine and practically no students possessed one. Some specialists may be found who declare that the days of the microscope are now over, probably a partial and propagandist view. But ten years are enough to cover the latest revolution in medical outlook, for the rise of physiology to its present dominating position is scarcely older. Sir Charles Sherrington, speaking at the London (Royal Free Hospital School),

of Medicine for Women, said the average annual earning of the medical practitioner in England to-day had been put down at between 500l and 600l. The estimate is surprisingly low, and, if trustworthy, should be a salutary reminder that extravagantly paid specialists must constitute but a small group within the profession of medicine. It was not, to his mind, a discouraging average in the era before us, "which must, perforce, be one of national economy and fortitude." Bread alone would not account for the enthusiasm shown in the choice of medicine as a calling. Sir Arthur Keith, addressing the King's College Hospital students, besides suggesting "a curious warfare between the stomach and the brain" (Carlyle, Darwin, Huxley and Spencer constantly complained of their stomachs), repeated a statement which he has made before, much to the pleasure of the lay press, that we do not use all our brains—that "there is no fear of using the matured brain to its fullest capacity." Sir Arthur, always a lively and suggestive speaker, has not, so far as we know, wholly elucidated this thesis. Why should we have inherited for a quarter of a million years, possibly for much longer, an organ of such intricacy if in all the generations of this considerable period we have never used it? Does Sir Arthur Keith mean quite what the newspapers—or even brother anatomists—understand him to mean?

WE have received notice to the effect that the Government of Bombay has been pleased to direct that the Bombay Bacteriological Laboratory at Parel should in future be designated "The Haffkine Institute." The suggestion of change of name appears to have come in the first instance from Lt-Col F. P. Mackie, who received the support of Major-Gen Hooton. The president of the Bombay Medical Council, and the Municipal Commissioner for the city of Bombay, saw no objection to the alteration. The laboratory was first started by Mr Haffkine in 1896 for the preparation of his plague prophylactic and was then housed in Byculla. Later (1899) it was moved to the present site and was called the Plague Research Laboratory and afterwards was named "The Bombay Bacteriological Laboratory." Since 1896, more than 25 million doses of plague vaccine have been issued from this institute, and it is considered just that Haffkine's name should be attached to the Laboratory on the analogy of the Lister or Pasteur Institutes. There must, however, be many who would not assign to W. M. Haffkine a place beside Lister and Pasteur. Waldemar Mordecai Wolff Haffkine comes of a Jewish family and was born in Odessa in 1860. He was educated in Odessa as a geologist, and after a short time with Schiff the physiologist in Geneva, migrated to Metchnikoff's department in the Pasteur Institute in Paris. Here he held a subordinate post and developed his ideas on cholera protection by inoculation. Through the influence of Lord Dufferin, especially, he went to India in 1893 and inoculated a large number of people against cholera and at a later period against plague. He was a man of uncanny enthusiasm and was

regarded by many as a prophet of a new regime. Thirty years' persistence of plague in India have not entirely established his fame as a great reformer.

IN the October issue of the *Forum* Dr E. E. Free discusses what he regards as "one of the most surprising failures of modern chemistry"—the failure to create life. For Dr Free the problem is really that of the origin of protoplasm, and he tries to reconstruct the environment in which its abiogenetic synthesis may have become possible. It is refreshing to find an American rejecting the Planetesimal Hypothesis in favour of the more recent views of Jeans. Few of the British school, however, will agree that after the earth had solidified, the sun's heat was still sufficient to maintain the surface at a temperature of 1,400° F. At a later stage during the cooling of the primeval atmosphere Dr. Free supposes that prussic acid and carbon monoxide were formed, followed by water, and he thinks it reasonable to assume that in the resulting ocean a natural synthesis of glycocoll and other amino-acids occurred. These had millions of years to be built up into more complex compounds, and at last the remarkable reaction was achieved whereby something akin to protoplasm came into being and started off the course of evolution that has culminated in man. The earliest known relics of life seem to represent bacteria, and on the other hand, glycocoll has already been prepared in the laboratory. The suggestion is that the gap is narrowing, and that chemists may soon succeed in synthesising "protoplasm." But it may well be doubted whether the chemist who first makes "protoplasm" will, as Dr Free appears to hope, have also created life. A piece of protoplasm cut from an *amaba* soon dies if it does not contain the nucleus, and it is surely unreasonable to anticipate that the chemist's "protoplasm" would fare so much better that it could reverse the process and come to life where no life had been before.

DR. ALEŠ HRDLÍČKA, whose lecture at the Royal Anthropological Institute on his recent visit for purposes of archaeological investigation to India, Java, Australia, and South Africa appears in another column, is universally recognised as one of the foremost of American anthropologists. For many years he has been Curator of Physical Anthropology in the United States National Museum at Washington. His first contribution to anthropological literature was made in 1895, when he published a report on an investigation of the characters of the inmates of an institution for juvenile delinquents, in which he was able to show that the theories of Lombroso on signs of degeneracy to be observed in the physical characters of the criminal had no basis of fact. Dr Hrdlička is perhaps best known for his work on the question of the antiquity of man in America. He has studied carefully all the osteological remains from that continent to which high antiquity has been attributed, and has visited the sites on which they were found. As a result of these investigations he was forced to the conclusion that neither in North nor in South America was there any evidence which

supported anything but a relatively recent date for the peopling of the continent. It has been an inestimable gain to archaeological studies that the first trained observer to visit the Broken Hill Cave and investigate the conditions of the discovery should be so stern a critic of evidence as Dr. Hrdlička.

IN a recent article (*NATURE*, August 22, pp. 265-267) on modern developments in British optical instruments, reference was made to the acknowledged superiority of British photographic lenses over those of foreign manufacture. It is satisfactory to learn from the makers of such lenses that the importation of optical glass for the manufacture of photographic lenses of the best type is now almost negligible. Before the War, the optical glass supplied by the one British manufacturer engaged on its production excelled that from abroad, kind for kind, both in transparency and homogeneity—the two essential properties, but only twenty-six types were available. These did not afford sufficient variety to meet the needs of the lens makers, who were thus dependent upon Germany, and to a less extent upon France, for their supplies of special glasses. The production of new types of glass was systematically developed in Britain during the War; and two additional firms took up its manufacture. There are thus three home sources of supply. The oldest of these firms now lists eighty optical glasses, and the quality of its products has been maintained. British photographic lens makers are now reaping the benefit of the enterprise shown by the glass manufacturers. The experience gained by the latter, combined with the research facilities now available, should assist them in supplying the optician with such new types of glass as may be called for as the result of developments taking place in optical science.

WE note with pleasure that work has been recommenced on the Exhibition Road frontage of the new buildings of the Science Museum, South Kensington. These buildings, planned some thirteen years ago, were supposed to have been completed in 1915, but while the skeleton ferro-concrete structure was being erected the War broke out, and the galleries were made later habitable for war-time offices by filling in the walls with temporary brickwork. This brickwork is now being demolished. It is thought the galleries will be completed in about two years and then the Museum will be in possession of suitable entrances, a feature it has always lacked. For years visitors have had to proceed by the rather disreputable passage at the side which suggests to one the entrance to a slum rather than a great national museum. We still think the Office of Works might make it less forbidding though it has to do duty for only two years longer.

ON September 30, in the Usher Hall, Edinburgh, before an audience of nearly three thousand people, Capt. Roald Amundsen was presented with the Livingstone Gold Medal of the Royal Scottish Geographical Society in recognition of his polar achievements. The Rt. Hon. Lord Salvesen, president of

the Society, in presenting the medal said that it was offered as a token of the admiration that Edinburgh people had for the gallantry, courage and endurance which Capt. Amundsen had displayed in the various arduous undertakings which he had initiated. The Livingstone Gold Medal was endowed to the Royal Scottish Geographical Society in 1901 by Mrs. A. L. Bruce in memory of her father, Dr. David Livingstone, to be awarded for distinguished services to geographical exploration or research. This special honour has been conferred on fifteen previous occasions, the recipients being Sir Harry H. Johnston, Dr. Sven Hedin, Commr. R. E. Peary, Capt. R. F. Scott, Sir Archibald Geikie, Sir George D. Taubman Goldie, Viscount Milner, Lord Avebury, Sir Ernest Shackleton, Sir John Murray, Capt. Evans, Lord Kitchener, Mr. Douglas W. Freshfield, Col. Frederick M. Bailey and Dr. Marion I. Newbigin.

As a sequel to the work of the Australian National Research Council in securing the foundation of a chair of anthropology in the University of Sydney, the Rockefeller Foundation is sending a delegation to Australia in November to visit the various universities and study at first hand their work and plans for research in anthropology and in all those sciences which may be grouped under the heading of "human biology." The delegation will consist of Mr. Edwin R. Embree, director of the Division of Studies of the Foundation, and Dr. Clark Wissler, head of the Department of Anthropology of the American Museum of Natural History.

IN the budget presented to the Commonwealth Parliament on August 14, provision is made for the appropriation of the sum of 100,000*l* for the purposes of the Commonwealth Institute of Science and Industry. This represents a very large increase in the annual income of this Institute, which will shortly be completely reorganised and put in a position to attack national scientific problems in a manner hitherto beyond its resources. Proposals for a new constitution have been prepared at the request of the Commonwealth Government by a conference representative of the chief industrial concerns and scientific organisations of Australia, but it is not yet known to what extent they will be accepted by the Cabinet and submitted to Parliament.

THE Russian Academy of Sciences has received information of the discovery of an ore containing a valuable radioactive uranic mineral. The ore was found by Labuntsov on the western coast of the White Sea in the course of investigations on some mica and feldspar quarries on behalf of the Mineralogical Museum. It is expected that further deposits of this ore will be revealed in those regions. Deposits of this nature were unknown in Russia before. Hitherto this ore was found chiefly in the Congo. Samples of the new mineral were on view at the Mineralogical Museum during the recent bicentenary celebration of the Academy of Sciences.

THE third International Limnological Congress was held at Moscow in the "Home of Science" on August

25-30. The opening of the Congress was preceded by a visit to Leningrad, where a public reception in honour of the foreign delegates was given by the Russian Geographical Society. The delegates then visited the Hydrological Institute, the Zoological Museum of the Academy of Sciences, the Botanic Gardens, and the Scientific Research Institute at Peterhof. At the close of the session the delegates left for Saratov to inspect the oldest biological station, whence they travelled down the Volga to the Caspian Sea, inspecting the Volga and Caspian fisheries.

A NOTE from Carl Meissner, now Curator of the Botanic Gardens at the University of Kowno, Lithuania, but formerly Curator of the Botanic Gardens, Leningrad, which appears in the *Gardeners' Chronicle* for August 8 last, throws a vivid light upon the difficulties under which plants have been reared at the Botanic Gardens, Leningrad, during and since the War. With improvised incubators or other heating arrangements, however, Meissner still succeeded in raising *Victoria regia* and sends an interesting photograph to the *Gardeners' Chronicle* which shows one of the floating leaves of this enormous aquatic plant supporting the weight of a full-grown woman (72 kilograms). The appearance of the leaf margin shows that this unusual weight is causing considerable distortion of the leaf, but it is a striking example of the great buoyancy and strength of this floating lamina.

THE Georgian Academy of Sciences (Tiflis) had recently organised an expedition to study the architectural monuments scattered in different parts of the country. The main objects of interest were found at Uplisziche, Samzevrisi and Svimosti. Uplisziche is a cave city hewn out in the rocky banks of the river Kura, near Gori. It is one of the most ancient architectural monuments in Georgia, part of the caves being traceable to the epoch of the Roman Empire, the majority, however, belonging to the Middle Ages. Samzevrisi and Zromi are represented by monuments of ecclesiastical architecture of the pre-Arabic period, while at Svimosti there is a basilica belonging to the eleventh century.

WE learn with regret that the Comptroller of the British Patent Office has been prevented by indisposition from attending the international conference on industrial property, which is being held at the Hague. His absence will mean a serious loss to the British delegation, for Mr. Temple Franks has earned a high reputation as an exponent of British patent law. At the last moment, however, Mr. H. A. Gill, president of the Chartered Institute of Patent Agents, was appointed to take his place, so that the delegation will not lack an experienced technical expert. The appointment of Mr. Gill was a wise step, particularly in view of the fact that, for some unexplained reason, no representative of the technical staff of the Patent Office is accompanying the delegation.

A SPECIAL exhibition of palæolithic implements recently discovered by Dr. O. Hauser in excavations in Saxony has been arranged in the Naturkundliches Heimat-Museum, Leipzig, and will remain on view until the end of November.

A PUBLIC inaugural lecture on "Science and Culture" will be delivered on Friday, November 6, at 5.30 P.M., at King's College, London, by Prof. Julian S. Huxley, who was recently appointed to the chair of zoology in the college, in succession to the late Prof. A. Dendy.

THE Chemical Engineering Group of the Society of Chemical Industry performs two useful functions, one of which is educational and the other commercial. Many of the papers read before it contain useful information which is not otherwise easily obtainable in a compact form; other papers serve mainly to direct attention to special types of plant which are, or may be, on the market. Volumes 5 and 6 of the Group's Proceedings, covering the years 1923 and 1924, have recently been issued under one cover; they contain thirteen contributions together with reports of the supplementary discussions. As types of the purely educational paper may be mentioned those by Mr. B. Heastie on heat-transmission and on water-purification; genuine research work is represented by a valuable paper on silica gel as an adsorbent, by Prof. E. C. Williams, of University College, London; and descriptions of manufacturing plant and processes are embodied in papers on the manufacture of wood-extract, water-softening, the extraction of oil from seeds, nuts, and kernels, centrifugal dryers and separators, the Premier and other disintegrating mills. Prof. J. W. Hinchley contributes an interesting paper on the large-scale manufacture of potash fertiliser, alum, etc., from Italian leucite, and Prof. F. G. Donnan gives some useful control formulæ for leaching and evaporating, with special reference to the Chilean nitrate industry. Several of the papers were communicated to joint meetings of the Group and other societies, and in many instances the discussions were informative.

A BIBLIOGRAPHY of meteorological literature prepared by the Royal Meteorological Society, with the collaboration of the Meteorological Office, has recently been issued by the Royal Meteorological Society. At first the bibliography formed part of the Society's Quarterly Journal, but since 1920 it has been published in six-monthly parts. References are added to the several papers to indicate where they are located. The divisions deal with general meteorology, methods of observation and computation, instruments, physics of the atmosphere, investigations of the upper atmosphere, the several elements of meteorology such as temperature and rainfall, climatology, and terrestrial magnetism. The publication is of value to meteorologists in different parts of the world. The price to non-fellows is 2s. 6d.

THE British Museum (Natural History) has recently issued Series 7 and 8 of postcards in colour illustrating flowering plants native to Britain. Each series of five cards (price 1s.) contains a brief discussion of the elements of the British flora, together with a list of the plants in the series, each with brief descriptions. The general account concludes as follows, after referring to some of the rarer elements in the British flora. "Rare

plants should not be picked except for special reasons, they should be investigated and left to seed. Wild-flower competitions in which children are told that they must actually pick a flower before they add it to their list are much to be deprecated."

We have received from the firm of Eisenschmidt, 60 Dorotheenstrasse, Berlin, a complete catalogue of German official maps, including the maps published by the various States and the geological maps. There is added a catalogue of Austrian maps. Full indexes of most of the issues are given with the catalogue.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned. A poultry instructor at the Norfolk Agricultural Station, Norwich—The Director of the Station, 11 Bridewell Alley, Norwich (October 17). Junior assistants at the National Physical Laboratory in the electricity and aeronautics departments—The Director, National Physical Laboratory, Teddington (October 24). Two research fellows in the department of Glass Technology of the University of Sheffield—The Registrar (October 24). An assistant for soil survey work in the Harper

Adams Agricultural College, Newport, Salop—The Principal (October 26). A professor of surgery in the University of Lucknow—The Registrar (October 31). A senior lecturer in botany and agronomy, and a lecturer in geography (especially in human and commercial geography), in the Transvaal University College—The Registrar, Transvaal University College, Pretoria (November 12). A professor of physics in the University College, Colombo, Ceylon—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W. 1 (November 20). An assistant lecturer in agriculture at the Harper Adams Agricultural College, Newport, Salop—The Principal. A senior hydraulic engineer by the Government of the Gold Coast—The Crown Agents for the Colonies, 4 Millbank, S.W. 1 (quoting M/13968). A computer for the Gold Coast Survey Department—The Crown Agents for the Colonies, 4 Millbank, S.W. 1 (quoting M/13965). Teachers for evening classes at the Northampton Polytechnic Institute in the subjects of mathematics, electricity, mechanics and heat, light and lens workshop—The Principal. A fellowship in chemistry at Trinity College, Dublin—The Registrar.

Our Astronomical Column.

MEASUREMENT OF PLANETARY RADIATION.—W. W. Coblentz and C. O. Lampland describe their researches in this field in *Lowell Observatory Bulletin*, No. 85. Various screens (fluorite, quartz, water, glass) were used to isolate different regions of the spectrum, bismuth and platinum-rhodium wires were chiefly used in the thermo-couples, tellurium wire is found to be still more sensitive, but its action is slower.

The percentage of radiation that is planetary (i.e. due to warming of the planet's surface or atmosphere) is 3 from Jupiter, 9 from Venus, 15 from Saturn, 30 from Mars, 80 from the moon. It thus increases with diminution of atmospheric density. It cannot be inferred, where the atmosphere is dense, that the surface of the planet is as cold as these figures would indicate. It is, for example, quite improbable that the surface of Venus (on the sunlit side) is near freezing-point; the measures really refer to a high layer in its atmosphere. The case of Mars is discussed in great detail. It is concluded that its day surface temperature may reach 10° or 20° C, while that of the moon may reach 80° or 100°.

Investigations on stellar temperatures were also made. The results range from 13,000° for ϵ Orionis, B α , to 3000° for Antares, M α , and β Pegasi, M β .

A NEW THEORY OF VARIABLE STARS.—Dr J. H. Jeans contributes a paper to the June issue of the *Monthly Notices of the Royal Astronomical Society* that contains some bold speculations connecting the long-period variable stars with spectroscopic binaries. He collects statistics of these binaries from *Lick Observatory Bulletin* 385, and deduces the mean value of the sum of masses of the two components as 18 (Sun), and the mass ratio as 0.73, the less massive star having the "earlier" spectral type. His suggestion is that the long-period variables represent the stage preceding fission in such stars. He postulates that both rotation and oscillation are present, and that the periods of these are at first different but gradually approach each other, becoming identical just before fission. The theory is shown to account

for several observed types of light curve, including the Cepheid type. Since even the M type variables have frequently a single definite period of light change, it is thought that these stars may have commenced the fission process in an earlier non-luminous stage. The author concludes that the temperature of both stars rises at fission, and thus explains the prevalence of type B in spectroscopic binaries.

SPIRAL NEBULÆ.—Dr K. Lundmark, who has for some years made a special study of these objects, has written a further paper on them in the *Monthly Notices of the Royal Astronomical Society*, 85, No. 8. He first discusses proper motions and radial velocities, the latter are concluded to reach a maximum of 2250 km./sec. at a distance of 110 Andromeda-nebula units, or 10⁶ light years. The sun is moving (relatively to the spirals) towards galactic longitude 75°. It is conjectured that this may arise from a rotation of our local stellar system in a period of 3.10⁸ years. The proper motions appear to be too small and doubtful for use. From the fact that they appear to be less than 0.01" annually, a minimum distance of 30,000 light years is found. Indirect methods give much greater distances. Assuming the novæ in spirals to be of the same character as galactic novæ, distances of the order of a million light years are found for the nearer spirals, in good agreement with Dr Hubble's results from Cepheid variables found in them. In this case the bright Nova S. Andromedæ, found in 1885, was of absolute magnitude -16, and was comparable with Tycho's Cassiopeia Nova. Dr Lundmark has found a star of magnitude 13.7 and spectral type M β , which is probably Tycho's star. Its spectrum shows giant characteristics, and it is concluded to have been of absolute magnitude -16 at maximum.

The paper concludes with some interesting speculations on the Lambert-Charlier suggestion of successively higher orders of systems, galaxies of galaxies, and so on. The facts, so far as known, are concluded to accord with the suggestion.

Research Items.

EXORCISM IN ZANZIBAR.—Mr W. H. Ingrams describes in the September number of *Man* certain customs observed by the inhabitants of the village of Makunduchi, Zanzibar, which are not found elsewhere among the natives of the island. The inhabitants of this village and the adjacent village of Jembiyani speak a peculiar and distinctive dialect, although both belong to the Wahadimu, the aboriginal inhabitants of the island. One characteristic feature of their culture is an exorcising dance performed by the women, the orchestra only consisting of men. The women possessed of the devil sit in a small tent while the dancers move backward and forward from sunlight to shade under a palm-leaf shelter. Some of the women carry iron tridents on long handles, others knives and swords, and others model outrigger canoes and paddles. As the devil cannot speak the local dialect, a special incomprehensible jargon is used. The devil can only be contracted at sea, and a legend of the origin of this state of possession has it that the devil first appeared from the sea in a canoe and holding a trident. It is suggested that the rite and legend may enshrine a memory of a cult of Poseidon introduced by early Greek sailors who, it is known, travelled along East Africa, and to whom the first description of Pemba and Rhapta is due. It is noted that a coin of Ptolemy X Soter has been discovered at Msasani, north of Dar-es-Salaam.

MAGIC AND MEDICINE AMONG THE AMERICAN INDIANS.—Mr. Charles Whitehead, of the U.S. National Museum, in Art. 10 of vol. 67 of the Proceedings of the Museum, gives an account of the Indian exhibits in the collections which illustrate the history of medicine. The Indians attributed disease to the operations of spirits, or it might be caused by absence of the patient's soul. Consequently the remedial measures were almost entirely magical, and even in the therapeutic use of plants, more importance was attached to their magical properties, the incantations with which they were gathered and the ceremonial accompanying their use, than to experience of their healing properties. In fact, their use was usually determined by some imagined resemblance or relation to the symptoms of the disease, or its mythical cause. Disease was closely connected in their myths with animals, especially the deer. Consequently, for a disease caused by the rabbit, the antidote must be a plant called the rabbit's foot, rabbit's ear, or rabbit's tail; for snake diseases the plant used is snake's tooth; for worms, a plant resembling a worm, and so forth. Their knowledge of surgery was based on a comparative knowledge of the anatomy of the higher animals. Splints, bandages, and the cautery were used, and bone-sets, cupping by sucking, poulticing, cutting, counter-irritation, and venesection were practised. For the last, small chips and flakes of flint were employed as lancets.

TYPES OF AVALANCHES.—In an article on "Les Catastrophes de la Neige" in *Matériaux pour l'étude des calamités*, No. 5, 1925, M. A. Allix suggests a classification of avalanches based first on the condition of the snow, and secondly on the effects of the avalanches. He recognises avalanches of dry snow, occurring below freezing point, and of wet snow, with a higher temperature. These produce respectively cold and warm avalanches, the terms being used relatively. Cold avalanches occur as streams of fine powdered snow following the snowfall. When once a crust has formed on the fallen snow it moves in slabs or flakes (*plaques*) to which different names are given.

Warm avalanches of wet snow occur in larger slabs of relatively slow movement, of which several forms are recognised. All avalanches have a common origin in loss of equilibrium. If the snow is in a state of unstable equilibrium, the most insignificant cause may start the avalanche. A fall of rock, the movement of a train in the valley, even the sound of a voice may furnish the secondary cause. Other causes also operate: unequal contraction due to rise and fall of temperature; saturation of snow with water; and lack of initial cohesion. The paper considers protective measures and includes a short bibliography of the subject.

THE MANURING OF FRUIT TREES.—In the *Journal of Pomology and Horticultural Science*, vol. IV Nos 3 and 4, June 1925, Mr T. Wallace makes perfectly clear the need for more scientific experiments upon the manuring of fruit trees, and commences the description of a series of manual experiments he has carried out at the University of Bristol Agricultural and Horticultural Research Station, Long Ashton, in which fruit trees, bush and smaller fruit, have been grown in sand culture in pots and supplied with mineral salts in solutions of known composition. These experiments should ultimately provide data of great interest to the plant physiologist, carried on as they have to be over long periods of time. In the present paper, the results obtained with apple trees, in experiments lasting over four years, are briefly given. In order to aid diagnosis of possible causes of trouble when the expert is called in to report upon lack of progress in fruit trees grown commercially, Mr. Wallace has adopted the plan of comparing the growth made by trees receiving all necessary nutrient elements with that made by trees in which one essential element alone is lacking. In four years, cultures along this line have yielded many results of great interest. For example, the large leaf growth and relatively good root growth obtained in cultures lacking calcium or magnesium compares strikingly with the poor root formation when potash is deficient, when the leaves also show great tendency to scorch and to fall early. Nitrate or phosphate deficiency is associated with late and weak development of both leaf and flower bud. Characteristic tints also appeared in the foliage before falling in many cases; thus magnesium deficiency was associated with purple blotches in the relatively large leaves before they fell. Such distinctions suggest that Mr Wallace's hope to obtain information of value for diagnosis, if applied cautiously to meet the problems arising in practice, is in a fair way to be fulfilled.

RAINFALL IN KOREA.—The Meteorological Observatory of Zinsen (known more familiarly to the western world as Chemulpo) has published a volume of remarkably complete statistics on the "Rainfall in Chôsen (Korea)." The text is entirely in Japanese, but the tables, which form the bulk of the work, have also English headings, and being accompanied by a series of excellent maps, ignorance of the language is no bar to extracting any information which may be desired. Although Korea was probably the first country in the world in which rainfall observations were taken at a network of stations (a number of rain-gauges were in use so early as A.D. 1442), modern meteorology is of very recent development, and in a country of the size of Britain there are records for only 215 stations, most of which were established less than ten years ago. Apparently no attempt has been made to correct these various short series to a common period, and the maps must be regarded as provisional.

only Nevertheless they give us our first clear idea of the distribution of rainfall in Korea. The annual amounts are similar to those in Britain, ranging from 18 to 68 inches, but the falls come chiefly in the summer monsoon in very heavy showers. Ten inches in a day have been recorded at many stations, and the maximum of 19.42 inches (485.5 mm.) in a day at Kosyu greatly exceeds anything known in Britain. The tables also include heavy falls in successive days, greatest and least monthly totals, number of days with various totals, and greatest falls in eight hours and in one hour. The latter table is based on self-recording gauges at eight stations.

THE ACOUSTICS OF HALLS.—The ease and certainty of the methods worked out by Sabine for the testing and improving of the acoustic properties of lecture halls are well illustrated by an article by Mr. A. G. Coombs in the September issue of the *School Science Review*. The new school hall at Berkhamstead was notoriously bad, the audience being unable to distinguish the words in the confused sounds that reached them. On shouting in the empty hall the reverberation continued for 10 seconds, and calculation of the time from the dimensions by Sabine's method gave 13 seconds. By covering the back wall and the ceiling under the gallery with 1800 square feet of "Cabot" quilting made of fireproof eel-grass, and the floor of the gallery with 850 square feet of cocoanut matting, the time of reverberation of the empty hall was reduced to 3 seconds, and of the hall and audience to 1.5 seconds, and it is now possible to hear in it without strain. The author has found the oboe suitable for producing the sound of constant loudness necessary for the tests.

BULLET PHOTOGRAPHY.—Although there is a general impression that the study of ballistics has made great advances since the War, it is only occasionally that an article dealing with such advances is published. The Bureau of Standards at Washington has designed an apparatus for bullet photography for the Frankford Arsenal, and Scientific Paper No. 508, by Mr. Philip P. Quayle, Assistant Physicist to the Bureau, gives an account of the apparatus and some of the interesting results obtained by its means. The spark is derived from a Leyden jar charged by an electrical machine and passes on the closing of a trigger spark gap by an electromagnet operated, without interfering with the bullet, either by the firing mechanism or by the passage of the head wave of the bullet over an interrupter. By means of the apparatus it has been shown that the service projectile from a 0.30 Springfield rifle ceases to be accelerated within a foot of the muzzle. Thirty-six figures are given, most of them photographs of the bullet with the head and sound waves, and several of them relate to the effects produced by the passage of the bullet through a soap bubble containing hydrogen (*v. also NATURE*, May 16, p. 765).

ROTATION OF THE PLANE OF POLARISATION OF ELECTROMAGNETIC WAVES.—Experiments with a molecular model consisting of four metal balls fastened together by wooden rods so as to form an irregular tetrahedron, which showed that in certain positions the plane of polarisation of an electromagnetic wave was rotated by this molecular model, have previously been described by Dr. Karl F. Lindman; and in the *Annalen der Physik* for August he describes a series of observations in which a considerable number of similar models with the balls embedded in spheres of paraffin wax were prepared, and placed in veneer or cardboard boxes which were put in the path of the waves. As many as eighty-five such molecular models were packed irregularly into a

single box, and it was shown that their action on the waves was that of a practically isotropic substance, the rotation of the plane of polarisation depending only on the thickness of the layer of models through which the wave passed, and not on the orientation of the box, the amount of the rotation being proportional to the thickness. The direction of the rotation depended on the form of the asymmetrical molecular models. Observations were made with waves of different frequencies, and it was found that the relation between the rotation of the plane of polarisation, the wave-length employed and the wave-length of the natural vibrations of the models agreed with the formula deduced from Drude's electrodynamical theory.

STEEL MOULDING SANDS.—The steel castings industry of Great Britain is notoriously inferior to the best continental practice, particularly German and Belgian. One reason for this is that insufficient attention is paid to moulding sands and their properties. A very comprehensive paper on "Steel Moulding Sands and their Behaviour under High Temperatures," presented at the recent meeting of the Iron and Steel Institute by Mr. A. L. Curtis, does something to remedy this defect. Mr. Curtis has shown that great variation occurs in natural argillaceous sands of Pliocene origin, of which the St Erth variety may be taken as representative, and that similar variation occurs in steel facing mixtures in current practice. It may be concluded, therefore, that much more frequent control tests are necessary before either choosing supplies of raw sands or preparing facing mixtures in the steel foundry. Mr. Curtis has developed certain tests, *e.g.* refractory and washing tests, which are more rapid than chemical analysis, and suggests that control tests could be rapidly made by these methods. He also describes permeability and dry crushing tests which afford a sufficient indication of the physical qualities of any resultant facing mixture. The factor of mechanical "green" strength has an important bearing on steel facing mixtures. Mr. Curtis indicates that results of his tests on these lines are in progress. The paper is fully illustrated with figures and photomicrographs. It should prove very useful to the industry.

MALLEABLE AND NON-MALLEABLE NICKEL.—For more than one hundred years after its application, nickel found very little industrial application. This was partly because the metal itself was not widely known and partly because as ordinarily produced it was non-malleable. In 1879 Fleitmann discovered a process for producing malleable nickel on a commercial scale, which consisted simply in adding about 0.1 per cent. of metallic magnesium to the molten metal just before casting. This process has been very successful, and is the method used to-day in the production of malleable nickel castings, and of ingot metal to be worked into sheet, rods, wires, and tubes. It has generally been supposed that it was the presence of oxygen which rendered the nickel non-malleable, and that magnesium acted as a deoxidiser. Recent work by Merica and Waltenberg has shown that this is not the case. Reference is made to this work in the *Metallurgist* of August 28. These authors conclude that neither oxygen, carbon, silicon, arsenic, iron, copper, cobalt, nor manganese impair the malleability of nickel. The harmful element according to them is sulphur, the presence of which, in amounts exceeding 0.005 per cent., is sufficient to cause lack of malleability in furnace-refined nickel. Magnesium as a desulphuriser is remarkably efficacious in removing the sulphide Ni_3S_2 , which is present as a eutectic, and surrounds the nickel crystals with a film which renders them brittle.

Dr. Hrdlička on Early Man.

AT a special meeting of the Royal Anthropological Institute held on September 29, when Sir Arthur Keith, ex-president, was in the chair, Dr. Aleš Hrdlička, of the Smithsonian Institution, Washington, gave an account of his recent journey to India, Java, Australia, and South Africa for the purpose of visiting the sites upon which discoveries relating to early man had been made, and exhibited bones and other relics from the cave at Broken Hill in which the skull of Rhodesian Man was discovered. These remains are to be deposited at the British Museum (Natural History) at South Kensington. Dr. Hrdlička said that on his arrival in India he was surprised to find that, in addition to the new species of fossil apes from the Siwalik Hills already known, two or three more new species had been discovered and were in the Calcutta Museum, but had never been described. Their discovery had been made by Dr. Pilgrim, superintendent of the Geological Survey, and there was a risk that these important investigations in the Siwalik Hills, where fossil remains abounded, might not be continued. In Java he had visited the site on which *Pithecanthropus erectus* had been discovered. Here again there was a great field for discovery, but priceless material which might bear upon the history of man was being lost for ever as it washed out of the deposits and was thrown away or destroyed by the natives. From Australia, perhaps, a great deal was not to be expected. The Talgai Skull was so nearly akin to those primitive specimens, the Australian skulls, that it may not be very ancient; but definite conclusions are not yet possible.

In South Africa, within the last four years, two discoveries of the greatest importance had been made—Rhodesian Man and the Taungs Skull. On the position of research in South Africa, Dr. Hrdlička had a great deal to report and a great deal that was favourable. In the matter of the finds themselves, some very important details were not yet known and had not been mentioned. Broken Hill itself, the kopje in which Rhodesian Man had been found, had now disappeared, owing to mining operations, but nearby was a similar hill, which, like Broken Hill, was honey-combed with fissures and caves in which it was hoped that further discoveries might be made. Dr. Hrdlička then described the mining operations which, in digging out the material of the hill from the top, had cut across a section of the cave. In clearing out this cave, which was full of refuse highly consolidated, it had been found that the upper and nearly level part before the steeper slope began, was nearly choked

with animal bones, which have now been smelted down. Here and there were softer spots from which the material had been thrown out into dumps. In the lower part of the cave were deposits which were nearly pure lead and of the consistency and colour of brown sugar. Near the cul-de-sac in which the cave ended, a miner named Zwiegler, working with a native boy, had brought to light the Rhodesian Skull resting on its base on a shelf as if placed there. No bones of any kind were near it. Under the skull was something which was described as a bag of "petrified" skin. This had now disappeared. From 3 to 6 feet further in had been found a human tibia, and still further a skull of a lion. Dr. Hrdlička had himself worked over the dumps which still remained and had found a stone implement, possibly part of a knife, a stone ball similar to some found before in the cave, a number of animal bones, some of which had been split as if to extract the marrow, and part of a humerus. Both the humerus and the femur, of which fragments were found, had been fractured in the same way and as if for the same purpose as the animal bones. The fracture of the humerus was undoubtedly ancient, and cannibalism would be no matter for surprise.

The discovery of the Taungs Skull, like that of Rhodesian Man, was wholly unlooked for in this part of Africa. It was an anthropoid of a new type, and it came from a site that was only partly exhausted. From pockets of soft pink limestone due to the filling in of caves which had formed in a hard ferruginous limestone plateau, large numbers of skulls of baboons were to be, and had been, obtained, and also in some cases where the skulls had perished, brain casts had been obtained. Dr. Hrdlička himself had found five skulls, of which he had succeeded in extracting three unbroken. These baboons had apparently crawled into the caves and fissures to die and had then been covered up by the deposit. Among these the Taungs Skull, the skull of a young anthropoid of a new species, had been discovered. It had been cleared of the deposit in a month's careful labour by Prof. Dart, and it was a tribute to his skill that the skull had not suffered a scratch in the course of the process. Arrangements had been made for a careful watch to be kept for any further discoveries and for Prof. Dart to be summoned at once should anything be found, so that it might be seen by him *in situ*. This skull was not the "missing link," but only one of many missing links, but in view of these remarkable finds, it was impossible to say what South Africa might not produce in the future.

Library and Information Service.

THE second annual conference of the Association of Special Libraries and Information Bureaux was held at Balliol College, Oxford, on September 25-28. Nearly two hundred delegates attended, which was more than double the number present at the first meeting. The diversity of interests attracted to the conference was surprising; scientific and research institutions, industry and commerce, and public affairs all being strongly represented. The marked variety of the professions of those attending caused widespread comment as to the real source of interest which was taken in the proceedings. A heavy, almost overloaded, programme of papers, numbering more than thirty, fully occupied the conference during the whole of the session.

Undoubtedly, the common link is the collection and the distribution of fact information. Special

organisations for assembling and systematically storing literature in limited fields of knowledge, and still more those for distributing information therefrom, for the service of their members or others, are found to be much more numerous than was previously recognised. The Association has done much good by demonstrating this, and is now engaged in pursuing some obvious developments which arise from the discovery. Most of these organisations are quite distinct from ordinary libraries, in fact, in some cases their own collections may be limited to indexes, or other aids to rapid contact with scattered outside library resources.

One of the first objects in view is the preparation of a "Directory of Special Libraries and Information Bureaux" in Great Britain, for which the support of the Carnegie United Kingdom Trust has been

obtained. This directory is intended to place on record the existence of all these bodies, and by suitable annotation to show clearly the field covered by the individual organisations and their facilities for a thorough command of their territory, even when their services are limited to the private needs of their members.

Another almost equally important object is the encouragement of an improved supply and a better distribution of scientific and other periodical literature, the vast extent of which has only just been clearly demonstrated by the publication of the *World List of Scientific Periodicals*, which will be referred to later.

The support of the movement for co-operation, nationally and internationally, in improving the service of abstracts in different branches of science, was discussed at the conference; and although there is no intention of such a youthful organisation venturing to interfere with matters which obviously belong to older and more specialised institutions, it is clear that a body of this sort provides a useful forum for diffusing knowledge of the results of experience in different branches of science.

The international outlook of the conference was demonstrated by the presence of M. Otlet, of the *Institut International de Bibliographie*, Brussels, and visitors from Germany, Holland, and the United States. The goodwill and friendly interest from the United States, where a *Special Libraries Association* has been in existence for sixteen years, was demonstrated by the reception of a presentation set of their journal and other tokens.

Sir Arthur Steel-Maitland, Minister of Labour, welcomed the delegates in an opening speech, and strongly urged the national importance of the work of the Association to enable Great Britain to maintain its position in the industrial field. He feared that both the U.S.A. and Germany were more diligent than was Great Britain in keeping track of the results of pure and applied research, and in providing the means for their record and diffusion.

Prof. Gilbert Murray dealt with the work of the *Intellectual Co-operation Committee of the League of Nations*, in a contribution of particular value, since so little is known in Great Britain of this branch of the League of Nations. Foremost in its activities was the support of bibliographical enterprise, and only the lack of funds limited the extension of this work, which was considered so important for reconstruction. "It is by reading one another's books that we get into one another's minds. It is by co-operation in scientific and philosophical research, it is by co-operation in building up literature and art of the countries that we can hope to get the minds of the different nations moving again in concord, and working towards something like a common end."

Dr. Chalmers Mitchell spoke of the "*World List of Scientific Periodicals*," which has just been published with the help of the British Museum authorities, and which discloses the existence of nearly 25,000 separate periodicals issued between 1900 and 1920. He explained fully his suggestion for a central library to contain a complete file of all periodicals publishing scientific research, the library to be kept available for abstractors and indexers, and to retain the periodicals for at least two years after publication. This library would be in no sense a rival to existing libraries, which would continue to form the permanent home of their own collections. In the past, many institutions had been proud of their possession of a few hundred or a thousand periodicals, the "*World List*" should encourage a wider view of the situation, and stimulate

co-operation and a pooling of resources so as to render available a better aggregate provision of literature for the scientific worker.

Sir Horace Plunkett described the *Co-operative Reference Library*, which it is hoped to transfer from Dublin to London. The conference passed a special resolution welcoming this proposal, as it was thought likely to be of great assistance in developing the agricultural progress of the country.

Miss A. L. Lawrence, of the *British Medical Association*, provided an interesting review of the "*Co-ordination of Medical Information*," describing work in the U.S.A., France and this country, which was usefully supplemented by Dr. O. Kentish Wright, with an account of the service of the Ministry of Health.

Mr. Langdon-Davies (*Labour Publishing Co., Ltd.*) explained that the relatively small editions of scientific books were not necessarily a drawback if some clearer forecast of the demand could be arrived at. In another direction, he hoped libraries and publishers would not overlook the extraordinary thirst for knowledge of the manual workers, and the resulting need of clear and simple exposition of scientific and literary subjects.

Engineering science was fully represented by papers from Brig.-General Mowat, with an account of the library of the *Institution of Mechanical Engineers*, and Major Simnett on engineering and transport intelligence.

The conference greatly appreciated the opportunity of hearing from Dr. A. E. Cowley, Bodley's Librarian, something of the work of that great institution, the Bodleian, which is more and more tending to departmentalise its collection to meet the growing specialisation of knowledge.

The session on Sunday morning was devoted to a series of papers by leading representatives of the library service of the three main political groups. The description of their organisation and work showed that a high standard of intelligence service is aimed at, going far beyond any narrow party need of the moment. The information sections of such government departments as the Board of Education, Ministry of Health, and Imperial Institute were described, and certainly widened the knowledge of most of those present as to sources available in this direction.

The field of general library administration is fully covered by the chartered "*Library Association*," and the friendly relations between this older body and the present gathering were demonstrated by the presence of several members of the Council of the Library Association, who contributed papers and took part in the discussions. An attempt is to be made to explore the possibility of closer relations between the two bodies, but it is clear that they function to a large extent in different directions, and the newer body mobilises, probably for the first time, the interests of library users.

Perhaps of even more importance than the formal discussions was the opportunity which the conference afforded for personal intercourse between specialists engaged in such diverse callings. Without the conference many of these might never have come in contact with one another for the discussions of the few, but important, matters which their professional interests have in common.

The immediate future task of the Association, the preparation of a *Directory of Special Libraries*, can be materially assisted by the goodwill and support of scientific bodies in response to a questionnaire which will shortly be issued by the organising secretary, Mr. G. W. Keeling, from the Association's office at 38 Bloomsbury Square, London, W.C.1. R. S. H.

University and Educational Intelligence.

ABERDEEN.—Dr. Alexander Low, reader in embryology at the university, has been appointed to the chair of anatomy, vacant through the resignation of Prof. R. W. Reid.

NEWCASTLE.—At the meeting of the council of Armstrong College held on October 5, Dr. Frank Smith was appointed professor of education in succession to Prof. Godfrey H. Thomson, who has been appointed to Edinburgh. Since 1914, Dr. Smith has been Senior Lecturer in Education and Master of Method at University College, Aberystwyth.

THE following lecture arrangements of the Royal College of Physicians of London have been made: The Bradshaw lecture will be given on November 5 by Dr. E. Bramwell, who will speak on "The Myopathies"; the FitzPatrick lectures, on "Medicine in Ancient Egypt, Assyria and Palestine," will be given on November 10 and 12 by Dr. A. Shadwell; the Lloyd-Roberts lecture will be given by Sir Arthur Keith on November 16 (the subject will be "Man's Structural Defects"). The Bradshaw and FitzPatrick lectures will be given at the College at 5 o'clock, and the Lloyd-Roberts lecture at the Royal Society of Medicine at 5.30.

FROM the Technological Institute, Cawnpore, we have received a prospectus which describes the arrangements made for putting into operation the scheme adopted by the Government of the United Provinces in 1921 for combining instruction in chemical technology with research in industrial chemistry. Three courses are offered, each of three years' duration, namely, in general applied chemistry, in oil extraction and refining, and in leather manufacture. The classes are limited to three students in each department in each year of the course, and only graduates in science are admitted. Arrangements have been made enabling students to receive practical training in oil mills in Cawnpore, Bombay, and Ahmedabad, and in the Government Harness and Saddlery Factory, Cawnpore.

ADULT education in some shape or form should be regarded by the whole community as a benefit in which every one of its members should participate as a matter of course. This is the ideal, proposed by the Master of Balliol at the annual conference, held at Oxford last month, of the British Institute of Adult Education—"a real students' university for adult education." Some account of the London County Council's efforts in this direction is given in "A Guide to Continued Education in London," a new edition of which has just been issued. In this particulars are given not only of classes in commercial and technical industrial subjects, art schools, and day continuation schools, but also of various kinds of "institutes," literary, women's, men's, and free, in which instruction of a more or less informal character is given. All of these are of recent origin, the latest being the junior men's institutes of which five have been opened experimentally for the season 1925-26. They are open daily from Monday to Friday from 7 to 10 P.M., and the subjects of instruction include "English in the form of topics of interest to boys, wood and metal work, 'hobbies,' gymnastics, and boxing." Every endeavour is being made to introduce the "club" atmosphere and influence so as to attract boys for whom the more formal instruction given at the ordinary commercial institute has no appeal.

Early Science at Oxford.

October 14, 1684. A letter from Dr. Turberville contained severall observations relating chiefly to ye eyes; and, which is yet more oblidging, it contained also his promise to communicate to us more observations of ye same kind. The Society then ordered, that their thanks be sent to ye Doctor, for what he has already imparted, and for ye hopes he gives us of a continued correspondence with him.

A discourse concerning Sands and Clays, and another discourse concerning the quicksilver in barometers, both written by Dr. Lister, were read.

Dr. Plot comunicated an abstract of a letter, sent him by Dr. Tyson, which is as follows: I have lately sent me, by Caspar Bartholin, a small tract he has put out *de ductu salivæ, hactenus non descripto*.—An Acquaintance of mine has lately put forth a Chronological Map from ye Creation to this time, in 16 large sheets of paper; which may either be pasted together in one or two maps, or else contrived conveniently into a booke.

He also communicated a substance, called *Solda*, which came from Timoa, one of ye Moluccas; it looked like an elmbark, had an aromatic smell, is an excellent Osteocolla, when pounded to powder, and put into spirits of wine.

He shewed us also a peice of silver talc, from Norway, on which fire makes no impression; and informed us, that in Staffordshire there are mountains of gold talc, which yeld not to violent fire.

The same Person shewed us a peice of copper, from ye East Indies; it was very heavy, of an irregular figure, like ye top of a cone, but flat; in which figure that mettall naturally grows in ye mines, whence this pattern was dug.

October 20, 1685. The Minutes of ye Dublin Society from July 6, to August 12 1685 were read, and ye thanks of ye Society ordered for them; there being mention made in them of wanting Insects according to ye matter of their ffollicles, thus method was supposed by Sr. Richard Bulkly then present at ye meeting to be impracticable, forasmuch as Insects of ye same species make use of materials of severall sorts, some of which are used by Insects of other kinds.

The same Gentleman was pleased to entertain ye Society with a farther account of his Calesh, which, he saies, is not onely uneasie, but dangerous for two persons to ride in at ye same time; but one person can travaile in it with greater ease to ye horse, than if he were on ye horse's back.

He gave ye Society an account of his Anemoscope, and presented them with draughts of a monstrous Child lately seen at Dublin.

There being some discourse concerning ye effect bleeding has on ye Eye-sight, arguments were urged from experience both for its being injurious, and its being advantageous to ye sight: Bleeding in fulnesse of vessels has cleared ye sight for some time, but frequently administered, and in a weak constitution, has taken from the strength of ye sight.

A letter from Dr. Vincent of Clare-Hall, Cambridge, concerning Dr. Papin's water engine, a letter from Mr. Over, Physitian at Winchester, to Mr. Coward of Merton College containing two cases of persons in ye small-pox, and a letter from Mr. Derham to Dr. Bathurst concerning some anatomical observations in dissecting a child, were all communicated and read.

October 21, 1684. A letter of Mr. Lewenhoeck's, being observations about the Chrystalline humors of ye eye &c, was read.

On October 21, 1684, mentioned frequently in ye Minutes of the Society, a great deal of rain, observed, and a hard frost.

Official Publications Received.

United States Department of Agriculture. Department Bulletin No. 1846. Status of the Pronghorned Antelope, 1922-1924. By Edward W. Nelson. Pp. 64+6 plates. (Washington: Government Printing Office.) 15 cents.

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 77: The Orthoptera of South Dakota. By Morgan Hebard. Pp. 33-155. Vol. 77: North American Veroniceididae. By H. Burrington Baker. Pp. 187-184+plates 8-6. (Philadelphia.)

University of London. University College Faculty of Medical Sciences. University Centre for Preliminary and Intermediate Medical Studies, Session 1923-1924. Pp. vi+225-258+10. (London.)

Aeronautical Research Committee Reports and Memoranda, No. 937 (Ae. 176). Experiments on the Transmission of Air Waves through Pipes. By L. F. G. Simmons and F. C. Johansen. (A.I.A. Dynamical Similarity, etc. 57-T. 1971.) Pp. 13+6 plates. (London: H.M. Stationery Office.) 1s net.

Jahrbuch der Zentralanstalt für Meteorologie und Geodynamik. Antilche Veröffentlichung Jahrgang 1921, Neue Folge, Band 58. Pp. xvi+486+338+C40. (Wien.)

Conseil Permanent International pour l'Exploration de la Mer. Publications de Circumstance, No. 68. On the Development and Distribution of the Norway Bullhead (*Cottus luteiventris* Collett). By Anton Fr. Bruun. Pp. 15. Rapports et procès-verbaux des Réunions, Vol. 87. Rapport Atlantique 1924 (Travaux du Comité du Plateau Continental Atlantique) (Atlantic Slope Committee). Publié avec l'aide de Dr. Ed. Le Danou. Pp. 89. Bulletin statistique des pêches maritimes des Pays du Nord de l'Europe. Vol. 12, pour les années 1921-1922. Rédigé par D'Aray Wentworth Thompson. Pp. 145. (Copenhagen: Andr. Fred. Høst et fils.)

The Science Reports of the Tohoku Imperial University, Sendai, Japan. Second Series (Geology). Vol. 7, No. 3: *Nissonia* Bed of Hokkaido and its Flora, by Seidō Endō; Nummulitic Rocks of the Islands of Amakusa (Kyushū, Japan), by Hisakatsu Yabe and Shōshirō Hanzawa. Pp. 87-93 +plates 11-22. (Tokyo and Sendai: Maruzen Co., Ltd.)

Transactions of the Royal Society of Edinburgh. Vol. 58, Part 3, No. 32: The Continuity of the Vertebrate Nervous System; Studies on Lepidodermatopoda. By Frances M. Ballantyne. Pp. 603-670+6 plates. 2s. Vol. 58, Part 3, No. 34: Studies in the Ammonites of the Family Echioceratidae. By Dr. A. E. Trueman and Daisy M. Williams. Pp. 609-789+4 plates. 6s. 6d. (Edinburgh: R. Grant and Son, London: Williams and Norgate, Ltd.)

Nigeria. Annual Report on the Agricultural Department for the Year 1924. Pp. 12. (Ibadan.)

United States Department of Agriculture Library. Bibliographical Contributions, No. 8: Author and Subject Index to the Publications on Plant Pathology issued by the U.S. Department of Agriculture up to January 1, 1925. Compiled by Jesse M. Allen. Pp. ii+158. (Washington: Government Printing Office.)

Contributions from the Central Meteorological Observatory of Japan. Vol. 1, No. 1. On Rayleigh Wave. By Hiroshi Nakano. Pp. 94. (Tokyo.) Publications of the Astronomical Observatory of the Warsaw Observatory. Vol. 1. Pp. iv+40. (Warsaw.)

Diary of Societies.

SATURDAY, OCTOBER 10.

BIOCHEMICAL SOCIETY (in the Biochemical Department, Cambridge), at 8.—Dorothy Needham and J. Needham. The Micro-injection of pH and rH Indicators.—G. S. Lund and O. G. L. Wolf. The Fermentable Sugar in Blood.—Sir F. G. Hopkins. An Oxidation of Proteins promoted by Glutathione.—Mrs. H. J. Coombs and Marjory Stephenson. The Gravimetric Estimation of Bacterial Growth.—L. J. Harris. Extension of the Principles of Acidimetry. Application to certain Biochemical Problems: (a) Analysis of Amino-acid Mixtures, (b) Volumetric Estimation of Casein and other Proteins; (c) The Rationale and Prediction of Protein Behaviour, (d) Polypeptides, (e) Insulin.—H. F. Holden. The Estimation of Glucose.—C. S. Hicks. (a) The Effect of a Tryptophane-Free Diet on the Thyroid Gland of the Rat, with Studies in Heat Production, (b) The Ultra-violet Absorption Spectrum of Acetyl-thyroxine.—C. S. Hicks and M. L. Mitchell. A Preliminary Report on the Study of Induced Polyuria in Rats.—H. W. Dudley and W. V. Thorpe. A Synthesis of N-methylputrescine and of Putrescine.—J. B. S. Haldane. The Effect of Diuresis on Purin Metabolism.—E. J. Channon and Prof. J. C. Drummond. Feeding Experiments with Spinnecens.

Mining Institute of Scotland (at Edinburgh).

MONDAY, OCTOBER 12.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Lieut.-General Sir William Leishman: Presidential Address.

INSTITUTE OF MECHANICAL ENGINEERS (Graduates Section), at 7.—G. Lyon: An Analysis of Tests on a High-speed Petrol Engine.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—J. Stirling: Chairman's Address.

INSTITUTE OF BREWING (London Section) (at Engineers' Club, Coventry Street, W.),—Discussion on this Season's Malta.

TUESDAY, OCTOBER 13.

PREHISTORIC SOCIETY OF EAST ANGLIA (at 52 Upper Bedford Place, W.C.), at 2.30.—M. C. Burkitt: Some Aspects of the Azilian-Tardenoisian Industries (Presidential Address).

INSTITUTE OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 8.30.—E. Parsons: Notes on the Geology of Java.

INSTITUTE OF MARINE ENGINEERS, at 8.30.—W. S. Patton: Corrosion.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (at 11 Chandos Street, W.), at 8.30.—Sir Percy Z. Cox: Mesopotamian

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—R. A. Hudson: Town Planning: its Effect and Influence on Industry.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. G. H. Rodman: The Story of Cuckoo Spit.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—F. Turville-Petre and Sir Arthur Keith: Early Man in Palestine: the Galilean Skull.

WEDNESDAY, OCTOBER 14.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. S. L. Cummins: The Prevention and Arrest of Tuberculosis.

INSTITUTE OF CIVIL ENGINEERS (jointly with Institution of Mechanical Engineers, Institution of Electrical Engineers, Institution of Naval Architects, Institute of Marine Engineers, North-East Coast Institution of Engineers and Shipbuilders, Institution of Engineers and Shipbuilders in Scotland, Institute of Chemistry of Great Britain and Ireland, Institution of Gas Engineers, British Electrical and Allied Manufacturers' Association, British Engineers' Association, Admiralty, War Office, and the Air Ministry), at 6.—R. A. Chattock: Standard Codes for Tabulating the Results of Trials on Steam Turbines and Condensing Plant.

INSTITUTE OF ENGINEERS-IN-CHARGE (at St. Bride Institute, Bride Lane, E.C.), at 7.30.—Eng. Vice-Admiral Sir George G. Goodwin: Presidential Address.

INSTITUTE OF CHEMICAL ENGINEERS (at Science Museum, South Kensington), at 8.30 (Reception).

THURSDAY, OCTOBER 15.

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street), at 8.30.—Major C. K. Cochran-Patrick: Aircraft Survey in Burma.

INSTITUTE OF MINING AND METALLURGY (at Geological Society of London), at 8.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Margaret Macmillan: The Future of the Nursery School.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Prof. C. V. Raman and Suvil Krishna Datta: On Brewster's Bands. Part I.—W. G. Collins: Demonstration of a New Method of Recording Rapidly Varying Phenomena.

CHEMICAL SOCIETY, at 8.—Prof. H. B. Baker and Miss M. Carlton: The Effect of Ultra-violet Light on Dried Hydrogen and Oxygen.—Miss M. Carlton. A New Peroxide of Barium.—U. R. Evans. The Production of Oxide Films on Copper at Ordinary Temperatures.—Mrs. A. H. Atack and F. W. Atack: The Structural Isomerism of the Oximes. Part III. The Benzilmonoximes.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Dr. A. Balfour: Some of Our Pioneers (Inaugural Address).

FRIDAY, OCTOBER 16.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating the Pathological Anatomy of Aconegaly.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. W. Bennett: Ely Cathedral (Lecture).

INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—Captain H. Vivian: Chairman's Address.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. J. Tracey: Super-Tension Cable Dielectrics.

INSTITUTE OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 8.—J. L. Adam: The Engineer and his Ship.

SATURDAY, OCTOBER 17.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital).

PUBLIC LECTURES.

SATURDAY, OCTOBER 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Earliest Egyptians and their Remains.

MONDAY, OCTOBER 12.

UNIVERSITY COLLEGE, at 5.—R. J. Lythgoe: The Physiology of Hearing and Vision (Succeeding Lectures on October 14, 15, 21, 22, 23, November 2 and 4).—Prof. G. Dawes Hicks: The Philosophy of Bradley and James Ward.

KING'S COLLEGE, at 8.30.—Rev. Dr. F. A. P. Aveling: Applications of Psychology.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. L. S. Burrell: Tuberculosis from the Physician's Viewpoint.

TUESDAY, OCTOBER 13.

BEDFORD COLLEGE FOR WOMEN, at 12 noon.—Miss Tarrant: Greek Philosophy.

UNIVERSITY COLLEGE, at 8.—Prof. E. A. Gardner: Proposals for Restoration and Excavation in Athens.

GREENHALL COLLEGE, at 6.—Sir R. Armstrong-Jones: Physics (Succeeding Lectures on October 14, 15, and 16.)

WEDNESDAY, OCTOBER 14.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. L. Rodwell Jones: Geography and the University.

UNIVERSITY COLLEGE, at 8.30.—Dr. E. A. Baker: The Use of Libraries.

THURSDAY, OCTOBER 15.

UNIVERSITY OF LEEDS, at 5.15.—A. M. Woodward: The Excavation of Sparta.

KING'S COLLEGE, at 8.30.—Prof. C. Burt: The Contributions of Psychology to Social Hygiene.

SATURDAY, OCTOBER 17.

KING'S COLLEGE, at 8.30.—W. J. Perry: The Story of



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Co-ordination* of Food Research.¹

THE appointment of the Imperial Economic Committee was a further step in the evolution of the Empire, and, should it be successful, an important one, for the aim is to promote "the greater prosperity of the Overseas Empire, the better distribution of the white population within the British Commonwealth, and the better employment of the population which remains at home." This the Committee hopes to accomplish by devising "methods of turning the trend of commerce into channels which will most effectively assist in the development of the Empire"; and it goes on to say that this "is a task at once complex, difficult and delicate, and [one which] cannot be hurried"—a conclusion with which few will disagree.

This first report before us confines itself to food, and the daily press has familiarised the public with the main feature of the proposals put forward, namely, the establishment of a permanent organisation, modelled broadly on the lines of the Development Commission, designed to secure regularity and continuity of supplies, and to conduct a publicity campaign "calculated to appeal particularly to the young, so that a habit [of consuming Imperial products] may be engendered in the coming generation." It is obvious that the effects of such a campaign could not be wholly commercial. If it were successful, it must increase the sense of empire, and of imperial responsibilities in the people. Its political import, therefore, would be great.

The special interest of the report to readers of NATURE lies in Part II., which is headed "The Importance of Research." "We are impressed," says the Committee, "by the paramount importance of research in solving the problems of the food supplies of the Empire," and to meet this need it proposes what is neither more nor less than the establishment of an imperial scientific service with headquarters and institutions in every geographical unit. A beginning has already been made towards such a state scientific service. At home there is the Department of Scientific and Industrial Research; in Canada and Australia there are parallel organisations; whilst at the Cape there is an active scientific division of the Department of Mines. Co-operation already exists, but it is almost exclusively of the kind which commonly takes place in the scientific world—interchange of papers and letters, and, much more rarely, of actual workers. The Committee aims at something more, namely, the co-ordination of these several and scattered organisations into a real imperial scientific service for the application of science to the food industries. This it hopes to

¹ Report of the Imperial Economic Committee on Marketing and Preparing for Market of Foodstuffs produced in the Overseas Parts of the Empire. Pp. 38. Cmd. 2493. (London: H.M. Stationery Office, 1925.) 9d. net.

attain by strengthening the scientific organisations in each country, and by establishing a system of studentships and grants which shall make it easy for scientific workers within the service to move from one part of the Empire to another.

Ultimately, the Committee hopes to see developed "an organised profession, trained at the Universities, specialised at the Research Stations, practised in research on a commercial scale, and utilised and rewarded in the trade at large," and "a professional institution which would play the same part in the food industry as that played by the Institution of Civil Engineers and the Institution of Mechanical Engineers in their industries."

That there is room for some such development as the Committee has outlined is not open to doubt. The application of science to the handling of food is patchy. On the engineering side it is good—cold storage engineering, for example, is as completely scientific as any other branch of engineering. But on the biological side, the industry, broadly speaking, is unscientific, and there is a great field for the application of botanical physiology, of biochemistry, and particularly of colloidal chemistry, to the problems of the storage of flesh, fruit, and vegetables. The food industry needs not only laboratory work on the biological side, but also infiltration by men with some training in the biological sciences—all this the Committee recognises. Before these aims can be attained, however, much persistent advocacy will be necessary. It is greatly to be hoped, therefore, that strong endeavours will be made to press forward the recommendation of the Committee as to research, until the scheme suggested is put into practice.

The Fundamentalist Controversy in the United States.

- (1) *Both Sides of Evolution: a Debate.* By the Rev. Charles Spurgeon Knight. Pp. 233. (San Jose, Cal.: The Arthur H. Field Publishing House, 1925.) 1 dollar.
- (2) *The Dogma of Evolution.* By Prof. Louis Trenchard More. (Louis Clark Vanuxem Foundation Lectures delivered at Princeton University, January 1925.) Pp. vi + 387. (Princeton: Princeton University Press; London: Oxford University Press, 1925.) 16s. net.

THE nature of the fundamentalist controversy in the United States, and the issues that are really at stake in it, are admirably illustrated by these two books, which we propose to review together. The first is an account of a public debate which is stated to have taken place in some small town disguised under

the initial N—in what Americans are prone to call "the wild and woolly west"; the other is a series of lectures admirably thought out and expressed, delivered before an academic audience in Princeton in the cultured east. In the first book, it would be difficult to assign the palm for crudity of thought and expression between the supporters and opponents of evolution; but the second book is a mine of valuable facts and of thoughtful criticism, though, like the first, it contains a polemic against the theory of evolution in its ordinary American presentation.

(1) If we turn to consider the first book more in detail, we find that it consists of an introductory address on the history of the theory of evolution by the president of the State University, followed by a defence of evolution by Prof. Allen, the local biologist. This is succeeded by an attack on evolution and a defence of the doctrine of special creation by Dr. Barkly, who is apparently an eminent Californian divine. A rejoinder by Prof. Allen then follows, and the book concludes with a second attack by Dr. Barkly. As the author of the book is the Rev. Dr. Knight, who describes himself as pastor and evangelist, it is not surprising that he considers the supporters of evolution to have been finally vanquished, and that he is careful to let the Church speak last. From the preface we might be disposed to infer that the president, Prof. Allen, and Dr. Barkly are imaginary characters, and that the whole of the arguments are the outcome of Dr. Knight's brain, and for the credit of our biological confrères in California we hope that this is indeed the case.

We note to begin with that the word "Evolution" is understood in its widest Spencerian sense: it is defined as including the nebular theory of Laplace and the supposititious development of living from non-living matter. It is evident from "Dr. Barkly's" rejoinders that what is chiefly attacked by the fundamentalists is this speculative extension of the theory of evolution, and we consider that the whole case for the validity of the theory of organic evolution is prejudiced by binding it up with such wild and baseless guesses as that for which the authority of Dr. Salesby (*sic*, ? Saleeby) is quoted to the effect that the ferments constitute the bridge between living and non-living substance, or that of Prof. Leonard Trolland, of Harvard, who states that life is an "autocatalytic reaction." If science be defined as the study of natural processes and the imaginary prolongation of them into the past and future, then no conclusion is more firmly based than that life only arises from pre-existing life, and that therefore in all sound theories of organic evolution the fundamental properties of living things must be taken for granted and are the postulate on

which all our reasoning is founded. If we make guesses as to the spontaneous generation of life from dead material, we are stepping outside science, and invoking what may be called an extra-natural or supernatural agency; and there science, which deals with processes and not with origins, comes to an end.

The supporters of evolution lay stress on the wonders alleged to have been performed by Dr. Burbank in producing new varieties of plants by crossing. These wonders, which have been "featured" in many popular western accounts of evolution, have evaporated under detailed criticism, and it is due to Dr. Burbank himself to say that he has never countenanced the extravagant claims which some of his admirers have made on his behalf. For the rest, the well-known arguments from embryology (including the tailed stage in the development of man), from palæontology, from comparative anatomy, and from the peculiarities of island species are somewhat vividly presented. We may note in passing, as an example of intense provincialism, the astounding statement that Prof. A. Franklin Shull had "demonstrated the descent of the elephant from the *Mœritherium* of the upper Eocene" (*sic*). That this demonstration was effected by our own beloved and deeply regretted Dr. Andrews, of the British Museum (Natural History), is overlooked entirely.

The attackers of the theory of evolution are, of course, quick to seize the opening provided for them by the inclusion of superannuated theories of cosmogony and guesses as to the origin of life within the ambit of the evolution hypothesis. That theories of cosmogony are in the melting-pot, it is easy, in these days of Einstein and of radioactivity, to demonstrate. Indeed, if "Dr. Barkly's" attention had been directed to some recent utterances by the talented secretary of the Royal Society, he would no doubt have felt his position strengthened. In the columns of *NATURE*, Dr. Jeans has discussed the number and variety of atoms which were originally "created." Dr. Barkly stresses the point to which we have alluded above, namely, that life is never generated from dead matter, but he goes on to say: "It should be remembered that spontaneous generation is a necessary part of evolution as held by most evolutionists. If this fails part of the foundation on which they erect their theory is shattered beyond repair."

When he comes to the field of organic evolution, most of Dr. Barkly's arguments are incredibly crude; but there are one or two of them that are worthy of attention. His trump-card is Mendelism, and he quotes Dr. Batson (*sic*): "That particular and essential bit of the theory of evolution which is concerned with the origin of species remains utterly

mysterious; we no longer feel as we used to do that the process of variation now contemporaneously occurring is the beginning of a work which needs only time for its completion, for even time cannot complete that which is not yet begun." There are many of us who fully agree with Dr. Bateson that the mutations with which Mendelians experiment have played no part in the evolutionary process; but so far from the genesis of species being mysterious, we hold that it is as clear as daylight to those who look in the right direction for a solution, and that nothing but the obstinacy of the Mendelians in persisting in searching in the wrong direction is the cause of the mystery which they find therein. When we discover that every wide-ranging species is split into local races, that a new local race establishes itself every time a new territory is colonised, that contiguous local races are fully fertile, *inter se*, but that distant races begin to show the mutual infertility which is characteristic of distinct species, we feel that the problem is in a fair way to its final solution.

Another argument of Dr. Barkly's is that domesticated animals and cultivated plants tend to revert to the wild type when neglected, and that therefore these breeds are not analogous to wild species. This, we think, is a valid argument. The diagnostic features of species are all reactions to their environment—in a word, adaptations to it—but the peculiarities of domestic animals, however useful to man, however "developed" from his point of view, are mere monstrosities from the point of view of the animals themselves, and owe their origin to disturbances of the developmental processes which result from the unhealthy conditions to which the germ is exposed at a critical period of its growth. As a consequence, we have "germ weakness" which is transmitted from generation to generation and produces similar results in each. But this germ weakness gradually disappears when normal conditions are restored; and so the domesticated pigs released in Jamaica in the seventeenth century have reverted to a form almost identical with the wild boar. It is, we hold, the one regrettable but natural mistake in the "*Origin of Species*" that Darwin considered these domesticated breeds as examples of the process which gave rise to new species.

It would be pointless and would weary readers of *NATURE* were we to recount Dr. Barkly's other arguments, such as: "If eyes were developed from pigment spots why are they not being developed now?" or "If this going backward from a hoofed animal down to a fish is not the opposite of all evolution, then the development of a horse out of a fish cannot be evolution at all, which, of course, overthrows the whole Darwinian theory at a blow."

Dr. Barkly's final reply is a pæan in praise of what religious teaching and religious belief have done in building up and upholding American civilisation. With much of what he says, all must agree; and it is the subconscious feeling that the American presentation of the theory of evolution threatens to undo the work of religion, which, as we have already pointed out in a previous communication to *NATURE*, is the driving force behind the fundamentalist movement. But though we have no desire to discuss religious questions in these columns, we cannot forbear to give one choice example of the crudity of Dr. Barkly's ideas: "Children always inherit through their parents—Jesus inherited through His mother for He was every whit a man, and He would have inherited through Joseph if Joseph had been His father, but in that case He could never have been more than a man. . . . The miraculous in His life is the manifestation of His Divine heredity." Comment is superfluous!

(2) It is a relief to turn from such outbursts of half-educated ignorance and prejudice to the calm scholarly and scientific atmosphere of Prof. More's book. In the series of lectures embodied in it he begins by emphasising the complete break between modern and medieval modes of thought which, according to him, began at the Renaissance. The first sign of the break began with the heliocentric system of Copernicus, but the Church did not realise the implications of this system until it was openly promulgated by Galileo, whose trial brought the conflict between the old and the new to a head; but, as Prof. More remarks, it is not true that opposition to science, whenever it has showed itself, is directed against the physical sciences themselves. Public opinion, according to him, is always indifferent to scientific theories, interest in which and eventual hostility to which are only aroused when they threaten to affect directly the social and ethical habits of society. It was because Galileo showed that the earth was only an inconsiderable member of the sidereal universe, and therefore could not be the main object of God's creation, that the outcry against him arose. Similarly, in the middle of the nineteenth century, it was not the change of one species of animal into another that outraged public feeling, but the theory that man was sprung from the lower animals, with the supposed bearings of this theory on such doctrines as the immortality of the soul.

Prof. More has some severe things to say about the "bluff" with which the propaganda in favour of evolution in the middle of the nineteenth century was conducted. The public were assured that natural selection was an all-sufficient explanation of the development of life, and that thought was nothing but molecular motion. Those who dared to raise

such questions as to how a negative process like selection, which is only a pruning-knife, could originate anything new, or how thought and knowledge, if they were merely accidental concomitants of molecular disturbance, could tell us anything of the external world, were shouted down. Prof. More deprecates the hero-worship of Huxley; and Huxley would certainly have disclaimed it for himself. Huxley, as Prof. More shows, was intensely human; he promulgated inconsistent views at different times; at one time declaring that the geological record was so imperfect that it could prove nothing about evolution, and at another founding the whole of the case for evolution on palæontology. Sometimes he preached pure materialism, and at other times he acknowledged that matter was inconceivable without mind to picture it in—which is simply Berkeleyan idealism. Prof. More also objects to Huxley's constant iteration of the purity of his love for truth—as More says, this savoured of brag, because it implied that he alone sought the truth and that his opponents did not.

Prof. More then gives a searching and critical exposition of the history of biological thought in ancient times: he is rather severe on his fellow-countryman, Prof. Osborn, whom he convicts of a very superficial acquaintance with the classics. For he points out that neither the Greeks nor the early fathers of the Church, whom Osborn had claimed as forerunners of Darwin, had the remotest conception of evolution. According to Prof. More, the idea that various groups of animals originated from a common ancestor could only arise when it became clear that fossil species had existed, different from those now living, otherwise why should we not assume that all the inhabitants of the earth began their existence together?

Coming to more modern times, Prof. More discusses the theories of Lamarck and Darwin and confesses himself strongly attracted to the former. He criticises some of Lamarck's ideas, such as his distinction between the action of God and of natural law, but he thinks that if experimental research bore out Lamarck's assumptions (and we hold that it does), then there would be little to say against the theory. When he comes to Darwin he deprecates hero-worship in his case just as in Huxley's case. He points out that the idea of natural selection came into Darwin's mind as a sudden suggestion when he was a young man, and that he devoted the rest of his life to the attempt to prove it to be true, so that his scientific method was deductive and not inductive. He is severe on Darwin's assumption that the aberrations of domestic animals are of the same nature as the adaptations of species, and he points out that Darwin was devoid of any training in the philosophic criticism of his own

ideas and did not realise that selection explained nothing and that his theory was really a theory of the constant occurrence of small inheritable variations in all directions (which the pure-line experiments have shown to be baseless).

In Great Britain the scientific bluff of the nineteenth century has been detected and discounted, with the result that the broad theory of evolution has been generally accepted by all the educated classes, and its acceptance is not regarded as involving a materialistic philosophy. But fashions in thought, as in clothes, often originate in Britain and are afterwards transferred to America, where they continue to flourish after they have become somewhat *démodé* here, and to judge from Prof. More's quotations, a crude mechanistic philosophy of life is still rampant in America. For in the last analysis we come down to the two alternatives: either what we call life, the external manifestations of which are concatenations of physical and chemical forces, is due to the arrangement of atoms in the living substance, or else it is due to the operations of an invisible entelechy or psychoid which uses and arranges these forces to gain a definite end.

Prof. More, who is a physicist himself, is mercilessly severe on the bad physics and worse chemistry with which the mechanistic biologists strive to cloak the inadequacy of their explanations. When the attempt of Verworn to show that the action of each living being was the result of its protoplasm containing a characteristic type of molecule (the mythical biogen) broke down and it became obvious that protoplasm is not a characteristic compound but a characteristic mixture of compounds, the difficulty of explaining how the typical proportions of this mixture were maintained became insuperable. The absurdity of some of the attempts to overcome this difficulty quoted by Prof. More, is almost incredible, as, for example, that of Prof. Ritter who maintains that every individual organism is a chemical compound! It is against the mechanistic view and not against evolution in general that Prof. More's whole polemic is directed, and he concludes with two chapters on "Evolution and Society" and "Evolution and Religion."

In the first of these chapters, Prof. More shows the impossibility of reducing sociology to the status of a definite science governed by fixed laws. He points out how all the prophecies of sociologists of the Spencerian type are being falsified by the trend of events, and that society in general does not "evolve" by the work of natural selection on the masses, but by the sporadic appearance of really great men and their incalculable influence on their fellow-humans. In the concluding chapter he develops this subject

further: he says that in the spiritual realm we do not observe regular progress, but extraordinary and unaccountable breaks; that no theory of evolution will account for Jesus, St. Francis of Assisi, or Pascal (nor, we may add, for Mahomet or Buddha), and that the wider acceptance of the theory of evolution has not led to moral progress as Spencer predicted that it would do. We may conclude this review by a quotation from this chapter: "If it were a general law that homogeneity changes to heterogeneity then all primitive stocks should progress if sufficient time be given. The contrary is the rule. Only a few primitive stocks have shown the power to progress to a high civilisation. . . . Unless they (the remainder) fall under the constraint of a foreign dominating stock we see no signs that they would ever advance to a complex or heterogeneous social state."

Is not Prof. Elliot Smith right after all?

E. W. M.

Lodge on Radio Communication.

Talks about Wireless: with some Pioneering History and some Hints and Calculations for Wireless Amateurs.

By Sir Oliver Lodge. Pp. xiii + 251. (London, New York, Toronto and Melbourne: Cassell and Co., Ltd., 1925.) 5s. net.

THE author in his preface describes this book as a friendly book. It is a message of greeting from one of the pioneers of the art of radio communication to the many who are following in his footsteps. He would be hard to please who did not find something acceptable and worthy of thought in these interesting chapters. The first part of the book describes radio in general. The second part gives hints that make for efficiency, and the final part gives methods of calculation which will be helpful to amateur constructors.

We have read the book with much pleasure. It is of great value to have on record views of the early history of radio communication by one who took a leading part in making that history. The book makes no pretence to be a complete history, but we think that the author has laid due stress on those discoveries and inventions which played a leading part in radio development.

No one has a more open mind than Sir Oliver Lodge. He is willing to investigate any phenomenon although it seems to contradict physical principles almost universally accepted. This attitude of mind is admirable. His statements, however, about the ether are perhaps too dogmatic. He believes firmly in the ether of space as a continuous reality which welds not only us but all the planets into a coherent system. "We are utilising it every day of our lives, and it would

be ungrateful as well as benighted if we failed to render due homage to its omnipresent reality and highly efficient properties." We think that this is putting belief in the ether on too high a level. Like the planetary electron, it is still unfortunately in the region of metaphysics. The hypothesis has proved of the greatest value in the past. It greatly simplifies our physical explanations of light, electricity, and gravitation, and no physicist hesitates to use it. But we must still recognise that it is only a hypothesis and be ready to change our views if anything more useful and convincing is suggested. It is advisable to take up a humble attitude.

Sir Oliver is enthusiastic about the modern methods of rapid transport and the greatly increased facilities for communication between inhabitants of this planet. But he points out that much more than physical and material progress are wanted before the much-desired, but long-delayed, era of universal peace can come. An essential preliminary is that every one should have a whole-hearted desire for the co-operative advancement of all nations on terms of mutual amity and goodwill. "Now that we are able to travel farther and faster, we should travel to some good purpose. And now that we can speak across a continent, let us see to it that we have something worthy to say."

It is perhaps going too far to state that we have extended the range of human speech to distances undreamt of by our ancestors. It is interesting to remember that the ancient Greeks contemplated not only the possibility of speech being heard at places hundreds of miles apart, but also that some of them believed that one at least of their philosophers could "broadcast." It is recorded that Pythagoras could be heard lecturing by different audiences in different towns on the same day and at the same hour. Whether Pythagoras anticipated Sir Oliver as a broadcaster or not, it shows that some ancient Greeks had considered the possibility and the effects produced by broadcasting. Unfortunately, the story of Pythagoras, who flourished about 500 B.C., is shrouded in the dim magnificence of legends.

The author points out that Joseph Henry in 1842 had the genius to surmise that there was some similarity between the ethereal disturbance caused by the discharge of a Leyden jar and that caused by ordinary light. In 1875, Edison observed that when an electric discharge took place, sparks ensued between neighbouring conductors, and Elihu Thomson investigated this phenomenon. A very important step forward was made in 1897 when Lodge showed how to obtain accurate tuning by the use of a coil of variable inductance. He also considered the possibility of transformer reception. Further great advances were made

by Fleming and Lee de Forest. Those of us who can remember the difficulties of reception twenty years ago regard the present easy methods of getting excellent reception as almost miraculous.

Many hints are given in Part II. which will prove useful to the amateur. He should use only wire of the highest conductivity, thoroughly insulate all his appliances, and make all joints as perfectly conducting as possible. Excellent chapters are given on the various methods of aerial excitation and on the grid as a "traffic regulator."

In the final part of the book, calculations are given suitable for amateur constructors. Stress is laid on the fact that the maximum possible inductance that can be obtained from a wire of length l is $3\pi nl$, where n is the number of turns of wire. If the inductance of the coil is not equal to $3\pi nl$, then it has not been properly made. Maxwell pointed out that it has this value when the radius of the circular section of the coil is 3.22 times the radius of the cross section. But in this case the formula from which the maximum value was deduced is only a rough approximation. If we take the much more accurate formula given by Rayleigh, we find that the ordinary method gives a result which is about 3 per cent. too small. The methods given of calculating the capacity of the aerial are only rough approximations and merely show the order of the magnitude of this quantity. The reviewer finds it very difficult to understand what radio engineers mean by the capacity of an aerial, although he has investigated several empirical formulæ which give results agreeing closely with measurements.

A. RUSSELL.

Liquid Fuels from Coal.

The Conversion of Coal into Oils. By Dr. Franz Fischer. Authorised English translation, edited with a Foreword and Notes, by Dr. R. Lessing. Pp. 284. (London: Ernest Benn, Ltd., 1925) 36s. net.

IN view of the fact that there are no appreciable sources of natural petroleum in Great Britain, and that the country is therefore dependent on overseas supplies for all its rapidly growing requirements, the importance of studying methods whereby substitutes could be provided by treatment of raw material indigenous to Britain cannot be overstated. The technical problems involved are being studied both at home and abroad by many competent workers, more especially in those countries which do not produce natural liquid fuel. Inquiry is also stimulated, even in those more fortunately situated, by the rapidly increasing demands for oil for all purposes.

During the past few years progress has been made in our knowledge of the constitution of coal both in

Great Britain and America, whilst many valuable contributions to the subject have emanated from Prof. Franz Fischer and his co-workers in the Kaiser-Wilhelm Institut für Kohlenforschung at Mülheim-Ruhr in Germany, a research institution which was inaugurated in 1914, shortly before the outbreak of the War. It is especially helpful at the present time to those workers who are seriously studying the subject to have available a translation of Dr. Fischer's work on "*Die Umwandlung der Kohle in Öle*" from one so competent to handle the subject as Dr. Lessing, himself identified with much valuable work on the constitution of coal.

In the treatise, the whole problem of the conversion of coal into liquids is critically surveyed. Naturally the book is largely concerned with the author's carefully planned researches extending over some nine years, but, at the same time, due consideration has been given to the work of other investigators, and if in certain cases the review of work in Great Britain and in America is somewhat sketchy, the fault lies in the break in the scientific relations between the various countries due to the War.

The subject matter is divided into five main sections, of which Chaps. 1 and 2 deal with the extraction of coal by solvents and the production and working of primary tar respectively. Most of the work described in these chapters has been dealt with adequately by British investigators and appears in the English literature. In Chap. 3 the hydrogenation of coal is considered at some length, but a much more extended description of the results achieved by Dr. Bergius of Mannheim might have been included. Chapters 4 (Synthetic Processes) and 5 (Hydrocarbons from Carbides) form the most valuable portion of the book, since they summarise, for the first time, the recent developments in the synthetic processes which Dr. Fischer has studied so intimately.

It is the author's evident belief that a solution of the light liquid fuel problem will, if found, lie in syntheses from the simple molecules of carbon monoxide and hydrogen, the coal being first broken down by some process and utilising the water-gas reaction to yield these molecules. He points out that "dry distillation is essentially a destructive method based on the thermal decomposition of the ulmins, and particularly of the bituminous constituents of coal," and that products of low boiling range, for which, of course, there is an almost unlimited demand, are formed only to a small extent. "The large size of the molecules of the compounds forming coal itself explains its behaviour on distillation, that is, the fact that thermal decomposition of the bitumen and the other coal constituents yields predominantly products of high boiling points." He considers, and with reason, that synthetic methods,

starting from very small molecules, are more likely to yield low boiling fuels than the method of destructive distillation.

Dr. Fischer therefore advocates first recovering the primary or low temperature tar by one of the destructive distillation processes, followed by complete gasification of the semi-coke. The gas so obtained forms the raw material for the preparation of a mixture of oxygenated synthetic oils produced from carbon monoxide by catalytic processes and which he has designated, "Synthol." This product consists of a complex mixture of diverse aliphatic compounds from which acetone, methyl-alcohol and ethyl-alcohol can if necessary be recovered by fractional distillation for use as solvents, the remainder apparently forming an excellent motor fuel. A few road tests are quoted in which comparisons are made between benzol, synthol, and various mixtures of benzol-synthol and benzol-alcohol-synthol, in which both mileage and starting properties compared favourably.

Interesting and valuable as this is as showing the possibility of obtaining from coal large quantities of lighter oils, it must not be forgotten that the process has still to be worked out commercially, and little data exist as to whether such a process can produce liquid fuels on a really large scale at a price competitive with natural fuels. In Great Britain the fuel problem is twofold, namely, to produce a solid smokeless fuel which can be burnt in existing grates, and at the same time to produce supplies of fuel oil, both light and heavy, for commercial and marine purposes. Some 35 million tons of coal per annum are burnt in the domestic grate, and should a stage be reached in which the bulk of this raw coal was subjected to preliminary carbonisation, a useful supply both of heavy and light oils would be available, but the coke would be required for household purposes. If, however, these methods can be developed successfully so as to be capable of application on a scale commensurate with the needs of a nation, there will be ample room for both, and the degree to which low temperature distillation would be combined with further treatment of the coke to produce liquid fuels would be determined in various countries according to their resources, requirements, and national habits.

In the foreword, the editor points out that he has adhered as closely as possible to the original text so far as is compatible with English phrasing. In an appendix, however, he has considered one or two of the latest developments of low temperature carbonisation, treatment of primary tars, and hydrogenation of coal, so as to indicate to his readers developments with which, for reasons already mentioned, Dr. Fischer could not be expected to be familiar. A useful bibliography

completes a work which should undoubtedly find a place in the library of the British chemists and engineers who are now working on the many-sided problem of rendering Great Britain to some extent independent of foreign sources for her supplies of liquid fuels.

C. H. L.

Botanical Text-books.

- (1) *A Class Book of Botany*. By Ernest Stenhouse. Pp. xi+514. (London: Macmillan and Co., Ltd., 1925.) 7s. 6d.
- (2) *A Textbook of General Botany*. By Prof. William H. Brown. Pp. xi+484. (Boston, New York and London: Ginn and Co., 1925.) 13s. 6d. net.

THE large variety of text-books of botany which have been published during the last few years, in Great Britain and in America, render it difficult for any addition to their number to present novelty of either treatment or subject matter. Most such works tend towards one of two extremes according as they appear to aim, on one hand, at imparting the maximum number of facts in the minimum of space, which in the hands of the inexperienced writer may lead to the endeavour to include all aspects of the subject, even perhaps insecurely founded hypotheses; or, on the other hand, the author may emphasise the more philosophical aspects of the subject, sometimes even to the exclusion of essential data. The best text-books are those which most nearly attain the balanced combination of these two aspects, and whilst subordinating facts to the illustration of principles, nevertheless provide the student with such a foundation of knowledge as shall enable him to build securely the superstructure of his later studies. It is in the selection of the illustrative data and its manner of presentation as part of a co-ordinated concept of vegetable life that the student gains by the experience of the author, provided that the latter has not forgotten with the passage of time the rungs on which he slipped as he himself climbed the ladder of progress.

The two books under review illustrate the two tendencies indicated above. In the "Class Book of Botany," by Mr. Stenhouse, we are impressed by the large amount of information which it contains, especially since it is intended for the use of those preparing for matriculation and similar junior examinations. But the facts are somewhat insistent as such, their significance and co-ordination too little emphasised. A useful feature is that each of the numerous chapters is preceded by suggestions for practical work, including many of an experimental character. Also each chapter is followed by a number of questions from examination papers.

There is much that is admirable in Mr. Stenhouse's book, but we have an ever-present consciousness as we peruse its pages that we are preparing for an examination. That it may produce successful candidates is very probable, but whether it will create lovers of the subject for its own sake is less certain. There are numerous illustrations of which the line drawings are in many cases reproductions of well-known figures, whilst the half-tone blocks have mostly been prepared from Mr. Irving's excellent plant studies. The latter are indeed the chief redeeming feature of an otherwise uninspiring chapter on common British trees. It may be noted that, apart from the ground usually covered by text-books of an elementary character, the simpler microscopic structure of plants is described, and there is a short account of a few of the common types of plant community.

(2) Prof. Brown's "Textbook of General Botany" is likewise of an elementary character and covers much the same ground. The earlier chapters treat of the various regions of the plant considered from the structural and physiological points of view, whilst the later chapters are devoted to the subdivisions of the vegetable kingdom, heredity, geographical distribution, etc.

Here the treatment is much more general in character, and occasionally one feels that the author passes too lightly over the ground, but the spirit in which the book is written is well expressed by the author's statement in the introductory chapter that "all persons should have some knowledge of botany if only for the purpose of understanding better so important a part of their environment as the vegetable kingdom." The text is well illustrated with more than five hundred original figures, mostly taken from tropical or sub-tropical material, the utility of which, however, is somewhat discounted by the lack of annotation.

The text in both of these works is divided into headed paragraphs: a device which, if it has advantages, tempts towards a discontinuity of narrative that neither author has been able to resist.

E. J. S.

Bird Islands of Peru.

Bird Islands of Peru: the Record of a Sojourn on the West Coast. By Robert Cushman Murphy. Pp. xx + 362 + 32 plates. (New York and London: G. P. Putnam's Sons, Ltd., 1925.) 15s. net.

THE western coast of South America is washed throughout a large part of its extent by a great river of cold water, an arm of the Pacific Antarctic drift. This, the Humboldt Current, has effects upon climate, vegetation, fauna, and human affairs that are no less profound than those of the Atlantic Current in

north-western Europe. It is not until within nearly three hundred miles of the equator that the cold northerly flow leaves the coast, to sweep outwards past the Galapagos and become lost in the expanses of ocean. Thus, along the Peruvian littoral we have temperatures which are very low in relation to latitude, and where tropical jungles might be expected to skirt the coastward base of the Andean range there is a strip of arid desert fringed with barren islands.

It is owing to the Humboldt Current, therefore, that this region of the tropics has a fauna with marked Antarctic affinities. In latitudes where turtles might be expected to pull out on the beaches to lay their eggs in warm sand, we find instead penguins burrowing on a barren coast. To the current also is due the great abundance of life. For a variety of reasons the waters of this ocean stream are peculiarly favourable for the multiplication of diatoms; thus for the existence of immense quantities of fishes; and thus, in turn, for vast numbers of piscivorous birds. One more fact completes the chain of circumstances. The great colonies of sea-fowl nest on the islands, and as these are barren and unwashed by rain, the excrement of the birds accumulates to form great deposits of guano. This, then, is the origin of "the greatest modern industry based upon the conservation of wild animals."

Dr. Robert Murphy, now of the American Museum of Natural History, has made these matters the theme of an entrancing book, based largely on his own experiences during an expedition which was made possible by a bequest to the Brooklyn Museum, of which he was then curator. The object of the expedition was to investigate the oceanic conditions responsible for the abundance of life in Peruvian water, and the inter-relationships and distribution of this life; to make zoological studies and collections; and to observe the conditions of the reorganised guano industry. The results are attractively set forth in narrative form, with allusions to previous writers, and are of great interest from more than one point of view. There is much of oceanography and biology, and much particularly about the birds; while native customs, antiquities, history, industrial considerations, and the incidents of travel are all given their place.

The chief guano producers are four in number, all of them belonging to the natural order Steganopodes—a cormorant, two boobies or gannets, and a pelican. Of these the *guanay* or white-breasted cormorant (*Phalacrocorax bougainvillei*) is the most important. The reader of Dr. Murphy's book will not fail to gather an impression of the almost incredible abundance of this species, and of the extent and density of their colonies—where there may be three nests to the square

yard. A single island was estimated to have a population of five and a half million birds, old and young, to maintain which it is computed that not less than a thousand tons of fish would be required every day! One of the boobies (*Sula variegata*), although not producing so much available guano, is even more numerous. The reader who has ever watched a gannet dive from the sky, to spear a fish seen in the sea beneath, will surely marvel to read of a flock of a thousand *piqueros* plunging simultaneously on passing over a shoal.

The best guano has a nitrogen content thirty-three times greater than farmyard manure, and is much more effective as a fertiliser than any synthetic compound that has been devised. Its agricultural uses were known to the Incas before the Spanish conquest, and irrigation schemes and guano together helped to make fertile the desert levels of the coast. The island deposits were in these olden days worked in a conservative manner, and the birds were strictly protected. The lesson had to be learnt again, however, for when the value of guano was realised in Europe in the middle of last century an era of reckless exploitation began: the accumulation of ages was rapidly used up, one island being lowered in level by a hundred feet, while at the same time the productive birds became greatly reduced in number, both through disturbance of their nesting places and direct destruction. The birds and the industry would both in time have been wiped out had not wiser counsels prevailed (including the advice given by a British naturalist, Dr. H. O. Forbes, and by Dr. R. E. Coker of the U.S. Bureau of Fisheries) and the industry been placed under Government control by the Peruvian authorities. Extraction is now limited in amount and regulated in accordance with a system of rotation which reduces disturbance to a minimum; the birds themselves, with careful protection against human and natural enemies, are rapidly repopulating their colonies; and the industry prospers while building up its future as it goes.

Atmospheric Electricity. •

Électricité atmosphérique. Par B. Chauveau. Troisième fascicule: Généralités sur les ions, l'ionisation et la radioactivité. La conductibilité et l'ionisation de l'atmosphère. Pp. xi+240. 22 francs. Deuxième fascicule: Le champ électrique de l'atmosphère. Pp. x+264. 25 francs. (Paris: Gaston Doin, 1924 and 1925.)

IT is a remarkable fact, and one not easy to explain, that although some of the most important contributions to our knowledge of atmospheric electricity have been made by British workers, there is no book in

the English language dealing with the subject. The need for such a treatise has been constantly felt, especially when students have expressed a desire to undertake research on some problem connected with atmospheric electricity. Until quite recently, the only books to which such students could be referred have been written in German, and this has proved a great obstacle. The position has been very much improved by the almost simultaneous publication of two works in French, which language has much less terror for the average English student. One of these, "Traité d'électricité atmosphérique et tellurique," by E. Mathias, was reviewed in NATURE so recently as August 1 last, and now M. Chauveau's book, the first part of which appeared three years ago, has been completed.

We must congratulate M. Chauveau on having written an extremely valuable account of the present state of our knowledge of the electrical phenomena of the atmosphere. He has divided his work into three parts, each published separately, but this has only been done for convenience; the work must be treated as a whole, for the parts are not complete in themselves. The first part, which is an historical introduction, has already been reviewed in NATURE (vol. 110, p. 406, September 23, 1922). The second part, which was the last to be published, deals with the electrical field of the atmosphere; and the third part with ions, ionisation, and radioactivity. It is not necessary to give a list of the subjects dealt with, for one can sum up the contents of the book by saying that every piece of work of permanent value has been considered, and references are given to practically every paper which has ever appeared on the subject.

One is grateful to M. Chauveau for the descriptions he has given of the apparatus used and of the methods employed by the various workers. His summary and co-ordination of the great mass of results obtained is masterly and could only have been accomplished by one who has himself made a life's study of the subject.

On reading this book, the outstanding impression which remains with the reader is the enormous number of problems which are still unsolved. One has the feeling that we have as yet done little more than discover a large mass of almost unrelated facts. The only thing which seems to be common to all is the factor of electricity. The surface of the earth has a negative charge which undergoes daily and annual changes, to say nothing of abnormal variations due to meteorological factors; but we do not know whence this charge comes, nor how it is maintained; we do not know the cause of the daily or the annual variation; we do not even know whether these periodic changes are of a terrestrial or cosmical origin.

Then again, the air is ionised, but we do not know why it is ionised. The presence of radioactive constituents in the atmosphere would appear to offer a solution to this particular difficulty, but when we examine the matter more closely we find that the problem is not solved. The amount of radioactive matter is nearly ten times as great over the land as over the sea, yet the ionisation is practically the same over the centres of the oceans as over the continents. No one has yet proved a numerical correlation between the amount of radioactivity in the air and the state of ionisation.

What part does ionisation play in the whole phenomena? The amount of ionisation obviously affects the rate of loss of electricity from the surface, but does it determine the magnitude of the remaining charge? If so, and there is some evidence that it does, is the daily and annual variation of the potential gradient simply due to the daily and annual variation of the ionisation? For this there is as yet no evidence. In this connexion M. Chauveau appears to ascribe a rather more important rôle to the large ions than is usually done by other writers.

If the maintenance of the earth's negative charge is the greatest problem, the mechanism of the thunderstorm, with which the origin of the electricity associated with atmospheric precipitation is intimately bound up, runs it very close. M. Chauveau's treatment of this branch of the subject is very complete, and his description of the observational work is excellent. He is, however, not satisfied that the true mechanism of the thunderstorm has yet been discovered.

These are only a few of the problems still unsolved; the book is full of others to which we have not space to refer. We can only recommend that every one interested in the subject, especially those undertaking further investigation, should study this book very carefully.

G. C. S.

Our Bookshelf.

- (1) *Modern Diagnosis and Treatment of Syphilis, Chancroid and Gonorrhœa.* By Brevet-Col. L. W. Harrison. Pp viii+167. 10s. 6d. net.
 - (2) *Modern Methods in the Diagnosis and Treatment of Pulmonary Tuberculosis.* By R. C. Wingfield. Pp. xi+134+11 plates. 10s. 6d. net.
 - (3) *Modern Views on the Toxæmias of Pregnancy.* By O. L. V. de Wesselow and J. M. Wyatt. Pp. vii+99. 7s. 6d. net.
- Modern Medical Monographs. (London, Bombay and Sydney: Constable and Co., Ltd., 1924.)

THE rapid advance of scientific, as opposed to empirical, medicine has stimulated Prof. H. MacLean to edit a number of monographs dealing with subjects in which the average medical man, who cannot remain in contact

personally with the progress of all branches of his profession, must yet maintain his knowledge at a modern standard. In the first three monographs published, the editor and authors have succeeded admirably in presenting modern views with a brevity and clearness which will prove a great attraction to the medical practitioner.

(1) The first volume under notice carries the admitted authority of Colonel Harrison. It contains references to every clinical and pathological detail in the diagnosis of venereal disease, and clear guidance through the confusing list of drugs now used in its treatment. It is certainly the best book of its size on this subject.

(2) Dr. Wingfield's work is offered to the senior student and to the general practitioner; junior students are recommended to turn elsewhere for the basis of their knowledge of phthisis, and in view of the limited amount of clinical data given, this is sound advice. The greater part of the book is devoted to treatment, but as this is always considered in association with the patient's condition, clinical features are not neglected. Dr. Wingfield is an exponent of treatment by graduated exercise, and gives a good account of the successful methods adopted at the Brompton Sanatorium, Frimley. Fresh air is considered of value only from the point of view of improving the general health, and sunlight is only mentioned casually. A most valuable chapter for the practitioner is that on after-care, including rules for the estimation of progress. The book is well illustrated by X-ray photographs.

(3) The third work under notice is of necessity a much less dogmatic book. Here the authors can only sum up the progress made by research into an obscure though important subject; conclusions are more provisional, and practical help for those who have to treat the disease is scanty. This is consequent on the absence of any definite knowledge of the pathology of pregnancy toxæmias, and the authors have made the best of a difficult task. In the treatment of eclampsia, they are not in favour of terminating pregnancy except in very toxic cases, where Cæsarian section is recommended; in other cases they advise morphia, washing out the stomach, and an enema, but no other interference.

Animals in the Making: an Introduction to the Study of Development. By J. A. Dell. (Bell's Natural Science Series.) Pp. xii + 115 + 8 plates. (London: G. Bell and Sons, Ltd., 1925.) 2s. 6d.

THE appearance of this little book is most opportune. The teaching of biology in schools, as an introduction to the proper understanding of the reproductive processes in man, is being urged insistently by biologists, and the time seems to be approaching rapidly when biology will take its proper place in the school curriculum. The author of this book, himself engaged in school work and therefore familiar with the practical difficulties of teaching the subject to children, has here drawn up a course of quite easy laboratory exercises, designed to allow pupils to see and handle for themselves embryological material to illustrate the fundamental principles of animal development. The exercises are very simply conceived and are such as can, with ease and very little expense, be carried out in any school with the minimum of apparatus. They include elementary observations and measurements on growth,

and the principles and use of the simple lens and microscope.

With these aids to study, the development of the frog, fowl, and rabbit are followed through on living material, step by step, and the changes observed correlated with change in habits and mode of life. The full course is planned to occupy a year, and at the end of that time the pupil has gained a considerable insight into the processes of development, fertilisation, and growth, the nourishment of the young, and even into the cellular structure of animals. Such an insight cannot fail to be of the greatest value to the child as a preliminary to an understanding of the essential facts of human development. The author is to be congratulated on the production of an excellent little book which should be of real help to countless other teachers who are anxious to extend biological teaching in schools.

Ancient Warriors of the North Pacific: the Haidas, their Laws, Customs and Legends, with some Historical Account of the Queen Charlotte Islands. By Charles Harrison. Pp. 222 + 11 plates. (London: H. F. and G. Witherby, 1925.) 15s. net.

FOR a missionary who has spent forty years among the Haida, this must be regarded as a rather unsatisfactory book. There is no question as to the accuracy of what is stated, but it is slight and there is insufficient information concerning the social life and social organisation of the people. The title of the book would lead one to expect some account of their fighting and warlike expeditions, but the information on this aspect of their life is very meagre. The most satisfactory sections are those dealing with the shaman and his medical and other activities. The religious beliefs are dealt with. A brief account is given of the history, geography, natural history, and geology of the Queen Charlotte Islands, and also of their natural resources. In an appendix, measurements by Dr. Oettinger are given of a few crania.

The author claims that "these islands are a great reservoir of potential wealth and that as the demands of the civilised world increase their natural resources will be developed." Earlier in the book he says of the Haida: "They were once a powerful nation and the terror of all the surrounding tribes. One hundred years ago they were numbered by tens of thousands; now only about one thousand can be found. . . . Their history is only another example of the inability of the North American Indian race to survive in contact with European civilisation." Presumably Mr. Harrison considers that the Haida will have quite disappeared before the country is systematically exploited, but if he has any wish that "undoubtedly the finest and most intelligent race on the coast" shall continue to exist, his suggestion does not appear to be the best way to preserve them.

Grundzüge der Kolloidlehre. Von Prof. Dr. Herbert Freundlich. Pp. viii + 157. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1924.) 6 gold marks.

THIS book is written as a strictly non-mathematical introduction to colloid chemistry. The author's classical work, "Kapillarchemie," is mathematical, extensive, and designed for the advanced student and

investigator. By abbreviation and excision of mathematical deductions and numerical data, a very much smaller book has been prepared. It is easy to read, introduces the fundamental points, and can be heartily recommended as a sound, interesting, and adequate survey of elementary, theoretical colloid chemistry.

The subjects dealt with include the phenomena at interfaces (liquid/gas, liquid/liquid, solid/gas, solid/liquid), such as surface tension, adsorption, capillary-electric phenomena, and the properties of interfacial layers. The Brownian motion is discussed historically, and then are outlined the general properties of sols and gels, including the problem of the Liesegang rings. Brief accounts of clouds and smokes, and emulsions and foams, complete this useful introduction to the author's detailed book.

The reviewer takes exception to the statement (p. 165) relating to emulsions: "When one liquid is in considerable excess, it necessarily becomes the dispersion medium." The literature on colloidal chemistry records several examples of even 99 per cent. of one liquid being dispersed in 1 per cent. of another liquid. Also, both types of such concentrated emulsions are known, namely, oil-in-water and water-in-oil.

WILLIAM CLAYTON.

Die Kriegsschauplatze 1914-1918 geologisch dargestellt.

Herausgegeben von Dr. J. Wilser. (In 13 Heften.) Heft 1: Elsass. Von Prof. Dr. E. Kraus und Dr. W. Wagner. Pp. viii + 154 + 3 Tafeln. (Berlin: Gebrüder Borntraeger, 1924.) 13s. 2d.

KRAUS and Wagner's "Elsass" is the first in number of a series of monographs on the geology of some chief fields of the War. It shows the extent to which the German military staff used geological help. The series includes contributions to the geology of several areas in Europe of special interest which had been inadequately studied. Elsass, however, was geologically well known, though the province is tectonically complex because the Alpine movements have been superimposed on the older Variscan structure. The authors deal with the province in three divisions. In the North Vosges, pre-Cambrian gneisses and Cambrian rocks have both been folded by the Caledonian movements and succeeded by deposits ranging from middle Devonian to the Trias. In the Middle and South Vosges the gneisses are directly covered by Lower Carboniferous rocks; they have been altered by granites intruded during the Variscan disturbances which were followed by the deposition of the Permian and the Trias. The third region is the rift-valley of the Rhine with Oligocene, Pliocene, and Pleistocene deposits. The monograph contributes much fresh information, as well as summarising the evidence on these three important geological divisions.

Outlines of the Occurrence and Geology of Petroleum: an Introductory Handbook. By I. A. Stigand. With an Appendix on Geophysical Methods as applied to Oil-finding, by Dr. M. Mühlberg. (Griffin's Mining Series.) Pp. x + 246. (London: C. Griffin and Co., Ltd., 1925.) 10s. 6d. net.

MR. STIGAND's handbook is one of the most generally satisfactory of the many smaller works now available regarding the geology of oil. In the discussion of the

origin of petroleum he concludes that it comes from many different sources, but that the bulk of it is due to micro-organisms. The chapter on field structures is admirably clear and does not attach to anticlines the exaggerated importance often assigned to them. The author is optimistic as to the quantity of oil available; he gives a long list, stratigraphically arranged, of oil-bearing localities, and if most of them were to become important producers the future supply of mineral oil would be assured; but many of the places in the list will probably not yield oil in quantities of commercial importance. The author lays on the mineralogists the responsibility for the denial that coal is a mineral, whereas reference to the text-books by Miers, the two by Dana, and the handbooks of the Mineralogical Department of the British Museum would show that the mineralogists are not the authors of the definition which leads to that ludicrous conclusion. The most important part of the work is an appendix on oil-field survey by the torsion balance, by magnetic and electric methods, by the use of seismic and acoustic observations, and of radioactivity. There is a useful bibliography on this branch of oil prospecting.

Physical Chemistry: its Bearing on Biology and Medicine. By Prof. James C. Philip. Third edition. Pp. vii + 367. (London: E. Arnold and Co., 1925.) 8s. 6d. net.

THE principal new feature of the third edition of Prof. Philip's book is the increased attention which has been paid to problems relating to hydrogen-ion concentration—a purely physical conception which has proved of such value in biological problems that its development has been very largely due to the intensive study of the phenomenon by physiologists. References to recent work have also been given; however, in other directions, and additional matter in reference to the properties of membranes has been inserted.

Distillation in Practice. By C. Elliott. (Chemical Engineering Library: Second Series.) Pp. 188. (London: Ernest Benn, Ltd., 1925.) 6s. net.

MR. ELLIOTT's monograph forms a useful supplement to his "Distillation Principles," recently noticed in NATURE. The first five chapters consider the operation of the fractionating column with mixtures of two components. Accounts are then given of distillation apparatus, and the cases of ethyl alcohol, petroleum, and coal tar are specially considered. References to recent literature are given.

Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Edited by Oliver Kamm, Roger Adams, H. T. Clarke, J. B. Conant, C. S. Marvel, F. C. Whitmore. Vol. 4. Pp. vii + 89. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 7s. 6d. net.

THE fifth volume of this excellent series includes twenty-eight preparations, among which are cupferron, ketene, pyruvic acid, and triphenylmethane. It is indispensable to all who have to carry out preparative work in organic chemistry.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Losses in Trout Fry after Distribution.

MAY I ask the co-operation of readers of NATURE—fish culturists and anglers—in testing the reliability of some experiments which were designed to ascertain the numbers of trout fry which survived out of a given number distributed in depleted trout streams? The importance of the experiments can scarcely be overestimated, because if corroboration of the Board's results is obtained in different parts of Canada and in the United States, then, if economic results are aimed at, fry will have to be rigidly excluded from all waters excepting those which are known to be suitable.

Three public bodies in Canada co-operated in carrying out the experiments during the summers of 1923 and 1924: (1) The Ontario Department of Fisheries, which furnished the fry and fingerlings and in most cases distributed them; (2) the Department of Fisheries, Ottawa, which appointed an experienced hatchery officer to check the determination of losses; and (3) the Biological Board of Canada, which appointed Mr. H. C. White to carry out the operations in the field.

In 7 streams and 2 ponds a total of 95,700 fry or fingerlings were planted, some in June of 1923, and some again in June of 1924. In 6 of the streams the losses were apparently total at the end of three months. In streams and ponds combined, apparently only 1375 survived, being less than $1\frac{1}{2}$ per cent. of the total fry planted.

The method of determining the losses was that of seining the streams or ponds and counting the survivors. A net fine enough to catch the smallest fry, and long enough to stretch across a brook, is used. A stout brail or stick, about 3 or 4 feet long, is attached to each end of the net. Heavy leads are fixed to the lower side of the net, so that fry may not escape at the bottom. The upper side is held above the water by the two men who operate the net, one on each side of the stream.

The seining should be done over and over again—a dozen or more times if necessary, in fact, often enough to ensure that almost every survivor is caught. Towards the end of the seining it may be necessary to have a third man rile the water thoroughly by stirring up the bottom of the stream in advance of the two seiners. This was done in order to prevent the fry from seeing and avoiding the net. Some practice is necessary in seining, otherwise the results will be untrustworthy.

In one of the brooks seined by the Board it was found that the fry ascended the stream about 40 rods above and 90 rods below the point of distribution. If it is desired to shorten the distance to be seined, and catch all ascending and descending fry, then two fine wire screens should be placed across the stream, one, say, 20 to 50 rods above, and the other 20 to 50 rods below the point of distribution. In each of these screens there should be inserted a cylindrical wire fish-trap, funnel-shaped at one end and joined by a smaller cylindrical wire tube or sleeve to an opening in the central part of the screen, so that the trap can be removed and cleaned at pleasure. The screen and the trap should be carefully constructed so as to catch all ascending or descending

fry, and thus discover how many fry migrate up or down stream.

The outstanding causes for the high mortality which was found in south-west Ontario seemed (1) warm, stagnant, or peaty water; (2) enemy fish eating the fry, as shown by finding fry or fingerlings in their stomachs, and (3) lack of sufficient natural food.

The results of the Board's experiments thus far are a severe condemnation, not of fish culture as a whole, but of the prevailing method of distributing fry in streams, namely, dumping them at any point most convenient to a highway or travelled road. They should be distributed with fair uniformity along the upper stretches of streams or along the margin of ponds where trout naturally lay their eggs, if they can find suitable spawning beds.

The experiments demonstrate, or at least indicate: (1) a loss of 98 per cent. of the fry (for the method of planting used and the streams investigated) during the first three months after distribution; (2) consequently a greatly increased cost of production per fry; (3) the necessity of a thorough examination as to the suitability of every stream or pond in which it is proposed to plant fry.

At present we are planting fry in the dark, and in some cases we are feeding them to coarse or useless fish.

A. P. KNIGHT

(Chairman, Biological Board of Canada).

Kingston, Ontario,

September 8.

"Bordered" Squares of Fifth Order and their Magic Derivatives.

FIG. 1 is an ordinary "Bordered" square consisting of a "Heart" (in the associated position, the three rows, three columns and two diagonals of which sum to 39) and a "Border" formed of complementary numbers (25, 1, 24, 2, 23, 3, etc.). There are 26 such "Hearts" and 605 "Borders," and, including inversions of the "Borders" and reversions of the "Hearts," there are 174,240 squares of this type with one inversion that has a similar number. These "Hearts" can be in 21 positions in a square of fifth order, and altogether with these "Hearts" in all their positions, I have calculated that there are more than 649,000 squares of fifth order of this type of "Heart."

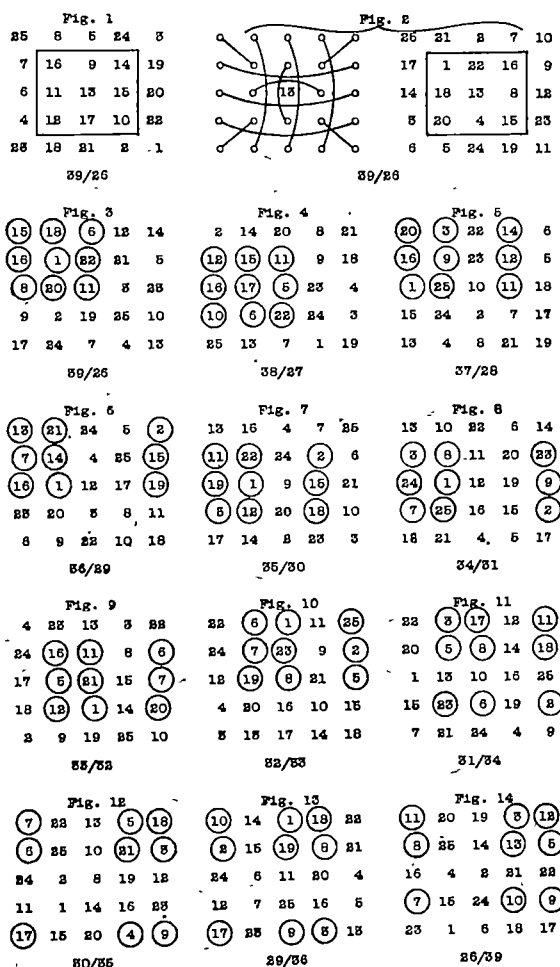
The above, however, are not the only kind of "Hearts." Fig. 2 shows another where the diagonals are not magic, that is, do not sum to 39 and do not have their complementary numbers in the heart. These are used for the corner numbers of the completed square. There are 135 such "Hearts" and 306 "Borders," giving a total of 88,128 squares with one inversion giving an equal amount. How many there are in the remaining 19 positions is quite unknown.

Fig. 3 shows still another kind of "Heart," where the diagonals are irregular and the number 13 is not in the "Heart." Thus the type of square of Figs. 1 and 2 is not feasible, but other positions of the "Heart" are practicable (see Fig. 3). There are only 12 such "Hearts" including the complementary "Heart," and the number of squares in all the different positions of the heart quite unknown.

So far in a square of fifth order, in a row or column the sum of the numbers of the "Heart" to the rest of the row or column has been as 39 : 26. But these are not the only proportions, and with certain exceptions all the proportions from 38 : 27 down to 26 : 39 can be made. The exceptions are 28 : 37 and 27 : 38, for which I have been unable to make "Hearts" under the conditions required. If in these squares each number be subtracted from 26, then the proportions

40:25 up to 52:13 can be obtained with the exceptions of 50:15 and 51:14 corresponding to 28:37 and 27:38. But none of these squares can be of the types of Figs. 1 and 2. The remaining figures give a square of these different proportions, and I have tried to illustrate some of the different possible positions of a heart in a square of fifth order.

Thus the number of "Bordered Squares and their



Derivatives" is very great, and if other known squares are included, such as pandiagonal squares, associated squares and their variations, rectangle squares, etc., the grand total of magic squares of fifth order, the 5 rows and 5 columns and 2 diagonals of which are magic, easily exceeds 1,000,000. I have accounted for more than a million myself, and that is without the many squares indicated above as unknown, the enumeration of which would be very laborious and intricate.

Barkston,
near Grantham, Lincs.

J. C. BURNETT.

On the Spark Spectrum of Lithium.

In a letter to the editor of this journal (NATURE, Feb. 7, 1925, p. 191) an account was given of a method for excitation of spark spectra, by which a vapour jet of the substance under examination is exposed to bombardment by electrons from an incandescent wire. During the development of the apparatus

certain modifications were introduced with the result that a very intense source of light has been obtained. Under ordinary conditions the current through the discharge chamber is of the order of 1 amp. and can be maintained during several hours. It has furthermore been possible to work with this discharge apparatus in connexion with a vacuum spectrograph manufactured by Adam Hilger, Ltd., in such a way that no fluorite windows are introduced in the path of light.

With this apparatus the investigation of the spark spectrum of lithium described in the former note has been continued, and it has especially been possible to extend the classification of the spectrum denoted by Schuler as the doublet system of the Li II spectrum by inclusion of a number of further lines. Table I. gives a survey of the hitherto observed lines belonging to this system. The lines marked with an asterisk were not given in my former letter. An estimate of the intensities of the lines, as they appear on the plates, is added in brackets.

TABLE I.

5484.7 (8)	2s-2p	*2657.3 (1½)	3p-6s
4881.3 (2½)	3p-4s	*2605.1 (1½)	3p-6d
4671.8 (3½)	3d-4f	*2507.0 (1½)	3d-7f
4325.7 (3)	3p-4d	*2430.0 (1)	3p-7s
3684.1 (2)	3s-4p	*2402.3 (1)	3p-7d
3195.8 (3)	3d-5f	*2381.6 (½)	3d-8f
3155.4 (2)	3p-5s	*2330.0 (½)	3s-6p
3029.1 (2½)	3p-5d	*1653.3 (6)	2p-3s
2728.4 (2)	3d-6f	*1493.1 (4)	2p-3d
*2674.4 (2)	3s-5p	*1198.0 (5)	2s-3p

TABLE II.

2s = 134,033 ($n^* = 1.810$)	3d = 48,834 ($n^* = 2.998$)
3s = 55,318 ($n^* = 2.817$)	4d = 27,467 ($n^* = 3.997$)
4s = 30,097 ($n^* = 3.819$)	5d = 17,574 ($n^* = 4.997$)
5s = 18,895 ($n^* = 4.820$)	6d = 12,203 ($n^* = 5.997$)
6s = 12,957 ($n^* = 5.820$)	7d = 8,964 ($n^* = 6.997$)
7s = 9,438 ($n^* = 6.819$)	
2p = 115,806 ($n^* = 1.947$)	4f = 27,435 ($n^* = 4.000$)
3p = 50,578 ($n^* = 2.946$)	5f = 17,552 ($n^* = 5.000$)
4p = 28,182 ($n^* = 3.946$)	6f = 12,193 ($n^* = 6.000$)
5p = 17,938 ($n^* = 4.946$)	7f = 8,958 ($n^* = 7.000$)
6p = 12,413 ($n^* = 5.946$)	8f = 6,858 ($n^* = 8.000$)

In Table II. the scheme of terms corresponding to this spectrum has been given, together with the effective quantum numbers (n^*).

It will be seen that the conclusions drawn in the former letter regarding the doublet spectrum are at all points confirmed. As regards the singlet system of Li II a few further lines in the far ultraviolet have been observed, and at the same time it has been found that several of the lines marked with an interrogation sign in Table I. of my former letter are due to impurities. It is hoped in the near future to bring a more complete term scheme of this spectrum.

SVEN WERNER

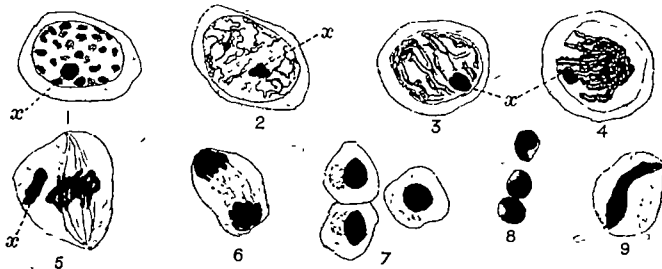
Universitetets Institut for teoretisk Fysik,
Copenhagen, September 10.

Spermatogenesis in a Spider (*Amaurobius sp.*).

At the suggestion of Prof. J. Bronte Gatenby, I recently made some preparations of spider's testis, in order, if possible, to test the accuracy of the observations described by Prof. Ernest Warren in a letter to NATURE of September 12. In my preparations I have found many of the appearances figured by Prof. Warren. Fig. 1, probably corresponding to Prof. Warren's Fig. 3, is an early prophase of the first spermatocyte division; the clumps of chromatin are the first appearance of the chromosomes, and one

clump (x), which is larger than the others, is presumably the sex chromosome. Fig. 2 shows a leptotene stage, Fig. 3 syndesis, and Fig. 4 a contraction figure in the diplotene stage. In all these, the sex chromosome can be easily distinguished, and in Fig. 5, which shows the chromosomes arranged on a normal spindle, the sex chromosome is seen lying apart in the cytoplasm. Fig. 6 shows the telophase of this division. The second spermatocyte division also appears to be normal.

There are, however, two kinds of spermatids; the larger, shown in Fig. 7, arises from the ordinary divisions described above, and gives rise to a normal spermatozoon; early phases of spermatoleosis are shown in Figs. 7 and 9. The smaller type of spermatid has a very small amount of cytoplasm; these



apparently abnormal spermatids supposedly arise either by an extra division of the ordinary spermatids, or by degeneration of the normal forms. It is thus plain that in the spider examined by me the whole course of spermatogenesis corresponds with that known in the great majority of animals; there is no evidence of amitosis either in the spermatogonial or spermatocyte divisions. Abnormal spermatids are known to occur in many insects and molluscs, and occasionally occur also in mammals. In such cases, however, the testis is found to contain normal spermatozoa, which presumably are the agents in fertilisation.

Zoological Department,
Trinity College,
University of Dublin.

S. D. KING.

Birth-Control among the New Zealand Maori.

MAY I, as a New Zealander, make a few comments on Prof. J. S. Huxley's very valuable review of "The Ethics of Birth-Control" (NATURE, September 26, p. 455). Europeans have found it almost impossible to elicit definite information from the New Zealand Maori regarding methods of control, although we have known quite well that control of fertility was exercised, and abortion is prohibited by the Maori Sacred Legends. Very few Maori women have more than four children; many fewer than four. In ancient times there was a betrothal for about eight or ten years, during which time no children were born. This betrothal was really a trial marriage. At the age of from twenty-five to twenty-eight, formal marriage took place between the betrothed lovers or otherwise, and the married woman had as many children as she desired, and by whatever father she desired.

Race improvement was taught in the Sacred Legends, and it was regarded as the duty of every mother to have as fine a father as possible for her child. If she wanted to live with her husband but preferred some other man to become the father of her child, she might allege that this lover's spirit

visited her. This was a recognised polite fiction. The husband might feel sorry his wife considered some other man a better potential father, but still he regarded himself as fortunate if his wife continued to love him and want him as her husband.

No man and no woman were allowed to reproduce unless passed as fit for reproduction by the Maori authorities; and before betrothal occurred there was medical examination of both parties by the parents of the young couple and by the doctors. Children were named by the community in accordance with their birth and form, and the girl-baby of a mother having difficult or abnormal childbirth was named in such a way as to indicate her unfitness for reproduction. Only the physically perfect men were permitted to become fathers, and no Maori woman

would allow herself to bear children by other men than these. The Maori considered the father of more importance than the mother in the matter of race improvement. Even crippled women might be allowed to become mothers, but crippled fathers—never. Scarcely any really "unfit" babies were born, but should such an accident occur, the new-born unfit baby was given "The Peaceful Death." Marriages were generally for life, and polygamy was rare. There were usually more men than women in Maori communities. Sexual hygiene and control were exercised. Some of these

practices I have detailed in "Safe Marriage" and "Sex and Exercise" (Heinemann's Medical Books); others will be detailed in "New Zealand Maori Sacred Legends," to be published shortly by Routledge and Kegan Paul.

ETTIE A. ROUT.

Choice of the Striking Point in the Pianoforte.

THE experiments dealing with the amplitudes of the partials from a struck string are many, and the conclusions are varied. For example, the experiments of W. H. George (*Phil. Mag.*, vol. 50, August 1925) show maxima at various points, and he arrives at the conclusion that the amplitude of the fundamental attains a maximum at a small distance from the bridge, while S. K. Dutta found that it attained a maximum at a distance of $1/91$, where l = length of string. Again, Berry's conclusion is that forced vibration is a maximum at $1/91$. Experiments made by me on the pianoforte have shown that the elasticity of the hammer must also be considered when calculating the duration of contact, which is of fundamental importance in the tone of the struck strings.

Recent experiments show that the amplitude of the fundamental and the octave, and the 2nd harmonic, are maximum when $T/\phi = 2$; T = period of vibration of the string, and ϕ = the duration of contact. Now ϕ depends upon the product of the striking distance and the mass of the hammer and its elasticity. The striking distance should not be very small, for then the resulting amplitude will be very small on account of the presence of the factor $\sin s\alpha/l$, where α = striking distance, and s is an integer. Secondly, it cannot be very large, for the reflection of the wave in presence of the load (hammer) would render the partials nonharmonic. Thus the striking distance must lie somewhere between $1/91$ and $1/71$. When α is fixed, the mass of the hammer and its elasticity are determinate. The best position of α is, however, obtained from the consideration of the note from the musical point of view.

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Practical Engineering in Ancient Rome.¹

By THOMAS ASHBY, D.Litt.

THE Palatine, the nucleus of the City of Rome upon the Seven Hills, had great natural advantages of position; it was an almost flat-topped hill, with two distinct summits and a slight depression between them, protected by lofty cliffs, far more formidable than they seem at present, and almost entirely surrounded by two marshy valleys traversed by winding streams. Its neighbourhood to the Tiber enabled it to command the crossing, which, no doubt, existed in some form long before the foundation of Rome, probably just below the island, where the Pons Sublicius stood later. This crossing was of great importance, for it was the only permanent one over the whole lower course of the river.

Even in the palmiest days of Rome there were no bridges over the Tiber below the city, and those that there are now are all quite modern; while if we look upstream we find that above the city the only bridge for forty miles was that by which the Via Flaminia recrossed the river into Umbria just below Otricoli—and of that the last traces were obliterated by a flood some twenty years ago, which led to a complete change of course of the river. The traffic between the two banks was probably carried on by ferries, as at present.

Tradition ascribes the building of the Cloaca Maxima to a powerful race of foreign kings, the Tarquins, from the city of Tarquinii in southern Etruria. Little or nothing remains that belongs to the original structure; and indeed in the time of Plautus it was called *canalis*, and may have still been open at any rate for part of its course; for the whole this seems an almost impossibly insanitary supposition. We have, too, a number of branch drains which must have eventually led into it from the slopes of the Capitol—though conditions have been so altered that some of them now give into the open. I think they may be claimed as dating from the sixth or fifth century B.C., and as being thus by more than a century the earliest Roman arches in existence.

In this connexion I would recall that here we are dealing with a soft volcanic stone—the kind of tufa known as cappellaccio. When Appius Claudius built the Via Appia in 312 B.C., and his engineers had to build an embankment wall to carry the road along a hillside, we may see that, where they had to deal with the hard local limestone, they did not waste labour either in making a curved arch for the culvert, contenting themselves with inclining the sides gradually and then putting a lintel over, or in making the courses of the embankment wall horizontal.

The course of the Cloaca Maxima, as shown on the map, resembles, as Lanciani remarks, rather that of an Alpine torrent than of a carefully constructed drain; and its origin, from the canalisation of a stream meandering at the bottom of a flat valley, as the Tiber does at present, is sufficiently clear. The mouth of the Cloaca, with its three concentric arches of volcanic tufa, which may be assigned to 100 B.C. or a little before, was much more picturesque before the construction of the modern embankment. It is now a mere dummy, as the Cloaca itself, which still performs its functions,

has been conducted into the new main sewer (the Collettore, as it is called) which runs just inside the embankment.

The Cloaca Maxima is a drain of considerable size, having an average measurement of 14 ft. high by 11 ft. wide, while the other two principal sewers of ancient Rome are rather smaller. Both these drains were built, like the Cloaca Maxima, of large rectangular blocks of stone, with a vaulted roof of the same material; and some of the minor drains were built in the same way, while others were covered with a flat block of stone, or with two slabs inclined to form a gable. This last shape, with the gable formed of large flat tiles, was that adopted in the brick-faced concrete sewers of imperial times, which vary in width from 2 ft. to 4 ft. and in height from 6 ft. to 9 ft.

Notwithstanding their splendid construction, which still bids defiance to the lapse of time, Lanciani is undoubtedly right in maintaining that the Roman Cloacæ have been overpraised. The modern sanitary engineer cannot approve of their use for carrying off sewage and rain-water together. Such contrivances as traps and syphons being unknown, the openings for the reception of the latter served to let out the effluvia from the former. Still more dangerous was the direct admission of sewage into the Tiber, which must have been odoriferous in the extreme when the water was low; while in times of flood the drains were dammed back, as was the case even in 1902.

In the time of the Republic the drainage system was under the general control of the censors, who let out contracts for the necessary constructions or repairs in this as in other classes of public works. They also had charge of the river banks and channel, and in 54 B.C. they erected a series of boundary stones (*cippi*) along both banks to prevent encroachment by private persons. Under Augustus in 8 B.C. the consuls of the year erected another series of terminal stones, and Augustus himself a third in 7-6 B.C.

Besides the erection of boundary stones, a good deal was done in the way of actual regulation of the river bank. There was no continuous embankment wall, as at present, but walls seem to have been built at the points where they were most needed. The Romans, at one point at any rate, at the Pons Aelius built by the Emperor Hadrian (the modern Ponte S. Angelo), were wise enough to provide three different widths of channel for different seasons of the year, in correspondence with which the bridge was provided with extra flood arches. The bridge was brought to light in its entirety in 1892, and it was found that, as originally constructed, it had three arches for low water, corresponding with a channel 66½ metres wide. Two more slightly smaller arches were available when the river was moderately full, with a channel 97½ metres wide. For great floods three smaller arches came into use, giving a total width of 135 metres to the stream. It was these three smaller arches and the bridge-heads characteristically sloping up on each side that were brought to light in 1892; and it is much to be regretted that it was impossible to preserve this remarkably perfect specimen of a Roman bridge.

¹ From the presidential address delivered at Southampton on August 28 before Section H (Anthropology) of the British Association.

From the consideration of the bridges of the city of Rome we naturally pass to that of the roads. The Via Appia, the queen of roads, as Statius calls it, was built as far as Capua in 312 B.C., and later on prolonged to Venusia (291 B.C.), Tarentum, and Brundisium (244 B.C.). It runs in a practically straight line from Rome to the Alban Hills. There it finds its first serious obstacle in the small extinct volcanic crater below Aricia, where Horace spent the night *hospitio modico*, not in the high-lying town, but at the post station below; and on the steep ascent from this post station it has, on the lower side of it, a massive embankment wall, about 200 yards in length. Thus, there is little doubt, is the *Pons Aricinus*, of which Juvenal speaks as being infested by beggars—like many another steep hill. The road soon reaches its summit level at Genzano, and descends once more in a straight line along the south-eastern slopes of the Alban Hills, passing at one point of its course over a smaller embankment, almost unknown to archæologists, and then, still perfectly straight, through the Pomptine Marshes.

Thence we arrive at Terracina. Above the town is the mountain, crowned by a temple of Jupiter Anxur, behind which the old road ran, keeping high above the sea, and descending again several miles farther on. Trajan is in all probability the author of the cutting at the foot of the isolated dolomitic mass of rock at the lowest extremity of the promontory, by which the road was enabled to pass round on the level. The height of the cutting is marked in splendid Roman numerals in swallow-tail tablets at frequent intervals.

After the two roads have rejoined, there is a flat stretch for some miles, with a number of ancient culverts and bridges, still used by the modern road; and then beyond Fondi the road enters the picturesque gorge of S. Andrea, where it is supported by massive embankment walls, well seen from the modern road, which has here abandoned the ancient line.

On the descent, in the modern village of Itri, we see the "Cyclopean" wall to which I have already directed attention, and shortly afterwards reach the Bay of Gaeta and Formiæ, where Cicero had his villa. From this point onwards the road proceeded on the level. Just before the fine bridge over the Volturnus, it joined up with the Via Latina-Labicana, and crossed to Casilinum, the modern Capua. Shortly after the ancient Capua the road enters the mountains once more, and after passing through the famous defile of the Caudine Forks, we find three finely preserved ancient bridges, of which the modern road still makes use. They are probably assignable to the period of Trajan.

We soon reach Beneventum, beyond which the course of the ancient Via Appia is so doubtful that there is no question of there being any remains of great interest. We shall, therefore, do well to follow instead the Via Traiana, which Trajan built as an alternative route to Brindisi, following an older mule-track of which Strabo speaks.

The road passes through some difficult country with frequent ups and downs, and there are a number of bridges in concrete faced with fine brickwork, stone-work being used sparingly, and then only at the base of the piers. These bridges are all 24 Roman feet wide, which is more than the usual standard width (14 feet) of the Via Appia and other Roman highroads—though

even they widened out somewhat at the bridges. From the summit, about 3000 feet above sea-level, there is a long winding descent, the Buccola di Troia, to the city of Troia, the ancient Aecæ, with its fine cathedral. Here we enter the *regna arida Daunii* and the plain of Apulia. The road crossed two rivers, the Cervaro and the Carapelle, both of which have changed their course, and so left their bridges high and dry in the fields. They are, from the great width of the valleys and the character of the streams, which are wide and shallow—in fact, almost dry except in times of flood, when they carry a great quantity of water—structures of great length. The first is about 280 metres in length, about half of which is accounted for by the bridge proper, a structure with at least fourteen arches, the principal one having a span of about fifteen metres. The second is much longer, beginning with a causeway 200 or 300 metres long; then follows the bridge proper, some 200 metres long, with about ten arches; and then follows a causeway about 250 metres long, with supporting buttresses on each side.

We may turn now to the Via Flaminia, the "great north road" of ancient Rome, built by Gaius Flaminius during his censorship in 220 B.C. The Via Flaminia, unlike the Via Appia and the Via Latina, is not able to maintain its straightness of line for very long after leaving the Tiber valley. It comes into some heavy country among the hills on the right bank, but the first really serious obstacle by which it is confronted is the valley of the river Treia, which is subject to violent floods, one of which, only four years ago, carried away the modern bridge just below Civita Castellana. The valley is about 1300 yards wide, and the drop in level to the bottom is about 250 feet on the south, while the ascent on the north is some 150 feet. The difficulties were considerable, but have been very well dealt with; and the causeways and bridge by which the Roman engineers took the road across the valley form a splendid monument of their skill.

After crossing the plateau to the north, the Via Flaminia descends to the valley of the Tiber, which is followed by the railway to Florence; and here we may see its parapets still preserved beside a modern road which has recently been constructed along its line. A few miles farther on, below Otricoli, it crossed the Tiber and entered Umbria, traversing a hilly district as far as Narni, perched on a lofty cliff above the river. Ascending through the town, it reached the famous Bridge of Augustus, one of the wonders of Italy even in the sixth century after Christ, as Procopius tells us. Of the four arches by which it crossed the stream, only one is now preserved. Many other ancient bridges are preserved along the course of the road. The only other important work of which I shall speak is the tunnel by which the passage of the road through the Furlo Pass is facilitated; the inscription recording its construction by Vespasian may still be seen above the entrance.

The aqueducts of ancient Rome are among its most celebrated monuments; but, conspicuous as are their remains within the city and in its immediate neighbourhood, less is known of them at a greater distance than might have been expected. I have myself been engaged in the study of them for more than twenty-five years, and hope shortly to be able to complete the work with which I have been occupied for so long.

For the present purpose, I shall confine my attention almost entirely to the four aqueducts which drew their supplies from the upper valley of the Anio, the Anio Vetus (272-269 B.C.), Marcia (144-140 B.C.), Claudia, and Anio Novus (both built by Caligula and Claudius, A.D. 38-52)—two of them, as their name implies, taking their water from the river itself; while the other two made use of excellent and very abundant springs which are for the most part conveyed to Rome by the modern Acqua Marcia, though a few of them still gush forth freely in pools which have a beautiful bluish tint (one of the springs was, indeed, known to the Romans as *Caeruleus*). These springs, indeed, as has been ascertained by the engineers of the modern aqueduct, come from holes in the roof of the original Roman headings. They rise under the rocks at the edge of the floor of the Anio valley, only a little way above the river-level, and come probably from huge reservoirs in the interior of the mass of Monte Autore, being supplied by percolation from a great basin about 1500 metres above sea-level, which is snow-clad for the greater part of the year. As the Roman headings lie some seven or eight metres below the present level of the valley, which has been much raised by floods, it seems useless to try to identify, as previous authors have done, the individual springs of which the Romans made use.

It will be convenient to follow the course of all the four aqueducts together, observing their principal remains as they occur. The Anio Novus originally drew its water from the river four miles above the springs of the Aqua Claudia, at the forty-second mile of the Via Sublacensis; but as the water was apt to become turbid, Trajan carried out a project of Nerva, according to which the three lakes used by Nero for the adornment of his villa above Subiaco were used as filtering tanks. This increased its length considerably, the new intake being some six or seven miles farther up. Considerable remains of the dam still exist on the way up to the far-famed monasteries; but the centre of it collapsed in a flood in 1305—as the story goes, partly owing to the malice or imprudence of some of the monks who began to tamper with it. Otherwise there are no remains of any particular interest until we reach the gorge of S. Cosimato, some fifteen miles farther down. It lies a couple of miles above Vicovaro, where the road from the valley of the Digentia and Horace's Sabine farm joins the main road down the Anio valley, the ancient Via Valeria.

From Vicovaro onwards, all the four aqueducts remain on the left bank of the Anio. The deep valleys of some of its tributary streams create considerable difficulties for the aqueducts, and great bridges were required to cross them.

Farther down, the Aqua Claudia and the Anio Novus leave the river valley, and reappear in a small valley leading southward to the Valle d' Empiglione, which is traversed by the road from Tivoli to Ciciliano and Genazzano. In this valley we find only one channel (where we should expect to find two), of rough concrete, belonging to the original construction, and measuring 1.20 metre wide and 2.60 or 2.70 metres in height—characteristic dimensions of the channel of the Anio Novus when running alone. It runs along the side of the valley, so that only one external wall is exposed, and this has later facing. The same difficulty presents

itself when we reach the main Valle d' Empiglione, for whereas previous observers have supposed that the two aqueducts which are here visible can be assigned respectively to the Aqua Claudia and the Anio Novus, the line going south belonging to the construction of the tunnel under the Mons Aeflanus by Paquedius Festus in A.D. 88, mentioned in an inscription, careful investigation shows that they branch off from one another at the north edge of the valley, and that the south branch falls slightly more rapidly than the other.

The south branch is undoubtedly still attributable to Paquedius Festus, and the western to the main aqueduct; but the problem of the existence of one specus only (which confronts us again at Ponte degli Arci, though not after we have passed Tivoli) remains at present insoluble.

The level of the bottom of the specus, at the beginning of the existing arches going southward (the northern extremity of the aqueduct near the road has disappeared), is 248.57, and at the end of the bridge it has fallen to 248.17, or 40 cm. in 349 m., which represents a fall of 1 in 872.5, or 1.15 per 1000. On the western branch the levels are 249.91 at the beginning of the bridge, and 249.83 at the end, or 8 cm. in 156 m., i.e. 1 in 1950, or 0.51 per 1000. Both of these falls are below the average fall in the long stretch of arches between Capannelle (where the aqueducts emerge from their long underground course) and Rome, which varies from 3.22 to 0.96 per 1000. The general average is 2 per 1000, but there is much variation.

In the next valley to the south is the only instance known to me of the existence of an alternative channel on an aqueduct bridge, which perhaps was provided in order to allow of cleaning before the beginning of the long tunnel, in which it would naturally have been exceptionally difficult. The tunnel must be about 2½ kilometres long, and the fall is 5.90 m. to the tank where the branch rejoins the main aqueduct, or 1 in 381, or 2.62 per 1000.

We must now return to the main line, which has a fine bridge, the so-called Ponte degli Arci, over a tributary of the Anio. The original bridge was a massive structure in *opus quadratum*, most of which has disappeared, though the impressions of the blocks are visible on the pier of the great brick arch on the south-west bank, and some of the masonry itself in the base of the last pier on the north-east bank. The brickwork with which the concrete of the greater part of the bridge is faced is, once more, Severan in character. When the aqueducts emerge on the hillside above Tivoli we find the four specus distinct from one another once more.

There is a very interesting point where from a reservoir of the Anio Novus a branch channel runs off, falling sharply (about 1 in 10), and supplying when required, by means of vertical shafts, the channels of the three lower aqueducts.

After passing the point of junction of the tunnel built by Paquedius Festus, the next feature of interest is the fine bridge known as the Ponte S. Antonio, which served to carry the Anio Novus across a deep and narrow valley. We may note here a right-angled turn, which often occurs, to break the speed of the water immediately before reaching the bridge. The channel is surprisingly narrow, being only 80 centimetres wide and about 3.12 metres high. The bridge was originally

a massive structure in ashlar masonry of volcanic tufa, and the fine central arch, 32.30 metres in height and 10.40 in span, is still visible on the west side. The width was originally only 2.60 metres and the total length is about 120 metres.

In the next valley, that of the Mola di S. Gregorio, there is a long bridge of the Anio Vetus, which, however, is a construction of the time of Hadrian, itself restored later—the change of period occurs in the arch over the stream. The original channel ran underground up the north bank of the valley until it could pass under the stream, and then returned on the south bank, where its channel may still be seen. It is, after all, unlikely that in 270 B.C. the Romans would have constructed an aqueduct above-ground which could so easily have been cut by an enemy, and Augustus followed the older line in his reconstruction. The bridge has a rapid descent of 2.92 in 25.30 metres, or 1 in 8.66, or 116.5 per 1000, at the end (the only case known to me at the end of a bridge) into the newer channel, which is some six metres higher than the older channel, with which it seems to have no communication. It continues to run for some way along the valley before it turns at right angles to tunnel through the ridge separating it from the next one, that of Ponte Lupo. The bridge had a total length of about 165 metres (with a fall of 1.06 in the main portion of 136 metres, or 1 in 129, or 7.75 per 1000), and a maximum height of 24.50; it has two tiers of arches for the most part, though the last seven on the left bank originally had only one.

We now arrive at the valle of the Acqua Nera, which is crossed by the Ponte Lupo, the best-known and the largest of the aqueduct bridges in this district.

It has hitherto been believed—and Mr. Newton and I still held that view when the drawings were made—that it carried all the four aqueducts. Accurate levelling has shown that this is not the case, and that the Anio Novus and Claudia both pass under the floor of the valley considerably higher up. This, indeed, gives them a much better line than the devious course which they would have taken supposing they had passed over Ponte Lupo.

The upper channel is, therefore, that of the Aqua Marcia; the fall from Ponte S. Pietro is 186.79–182.27, or 4.52 metres in about a kilometre, or perhaps more; for the specus, as usual, runs along the side of both valleys for some way both before and after the tunnel through the ridge. But there is a problem in regard to the Anio Vetus. At the last shaft of the earlier channel in the Valle della Mola di S. Gregorio the intrados is 168.86 metres above sea-level, while at the last shaft of the newer channel, after the bridge which Hadrian built, the intrados is about 172 metres above sea-level; the floor of the specus would be about 2.80 metres lower in each case. The level of the water of the Fosso dell' Acqua Nera is 155.19, and the bottom of the specus at the Ponte Tauella is 155.61. The distance between the last two points in a straight line would be not much over two kilometres; but along the line of the aqueduct it should be 21,120 Roman feet, or more than 7 kilometres according to the *cippi*.

It is thus quite impossible that the Anio Vetus should not have been above-ground at the Acqua Nera, unless it was carried under it by a syphon. There is, about 17 metres below Ponte Lupo, on the right bank

of the stream, a massive concrete buttress, faced with *opus reticulatum*, probably belonging to the time of Augustus, and containing a shaft, which, though blocked up, certainly seems as if it went down at least as far as the level of the stream, and might very well reach down to a channel passing under it.

The question why syphons were not made use of to take the aqueducts in a straight line (like the modern Acqua Marcia) across the Campagna from Tivoli to Rome (in which they would have come to intermediate levels considerably lower than that which they reach at Porta Maggiore), in order to avoid the long detour which we are now following, has been well answered by M. Germain de Montauzan in his book on the four Roman aqueducts of Lyon, in which no less than ten syphons have been observed. The Romans did not trust their concrete and cement for making syphons, though they might have done so. They were unable to make a large metal pipe that would stand pressure; and at Lyon the contents of a channel 0.58 by 1.75 metre are transferred to nine or ten lead pipes with a bore of 0.20 when the syphon is reached. We have only to calculate the enormous quantities of lead that would have been required to take the water from four channels, the largest of which measured nearly 1.20 metre wide and 3 metres high, and to remember that small-bore pipes would have been choked almost at once by the heavy calcareous deposit, to realise how impossible it would have been to adopt this method here. On the other hand, all the building material required was quite easy to obtain on the spot or not far off. But there is no objection to its use in a rock-cut channel for a short distance; and if we do not accept this view, we have to find a place for the specus of the Anio Vetus in the lower part of Ponte Lupo; and a careful study of its construction and of the dating assigned to its various parts by Miss van Deman has shown me that this is by no means easy, though from the levels it is admissible.

Raffaello Fabretti, one of the pioneers of the investigation of the aqueducts, whose work "*De Aquis et Aquaeductibus Urbis Romae*" was first published in 1680, marks the so-called Ponti Diruti as the last remains of the aqueducts visible towards Rome; and, indeed, it was believed until a few years ago that they ran underground from this point to the well-known line of arches which begin at Capannelle. Even Prof. Lanciani had written of all the four that there were no traces from Cavamonte to Roma Vecchia and Capannelle respectively. But the casual discovery of a part of the channel of the Aqua Claudia on the farm road leading to the Casale della Pallavicina directed his attention to the possibility of discovering the course of the aqueducts in this district; and he further suggested that the large amounts of calcareous deposits thrown out at the shafts (*putei*) which occur at frequent intervals in the subterranean course of the aqueducts were bound to reveal their course still further towards Rome, where they traverse the lower slopes of the Alban Hills. This proved to be the case; and it has thus been possible to follow them from point to point in their gradual descent towards the plain, until they emerge between the Via Latina and the Via Appia.

In all this stretch, however, there were no complicated problems of engineering to be solved; and we may therefore turn to the consideration of the remains

of the aqueducts after their emergence. The arches of the Claudia and Anio Novus gradually increase in height from Capannelle to Roma Vecchia, until beyond it they reach their greatest elevation in this section, estimated by Lanciani at 27.41 metres.* In this stretch they are extremely well preserved and have not required restoration to any considerable extent. The lower stone channel of the Claudia is surmounted by the concrete specus of the Anio Novus, faced with brick and *opus reticulatum*—an obvious afterthought, the detrimental effects of which we have already seen.

Further on, as we come nearer to the city, considerable reinforcements have become necessary. In many places the original stonework of the piers has been removed for building material, and Lanciani quotes the records of the sale of, e.g., two or four peperino pillars by the Hospital of Sancta Sanctorum at the Lateran, to whom the ground belonged. But, as he also points out, sometimes the brickwork was removed and the stonework left; or, again, the brick facing is sometimes hammered away from the concrete.

The question as to the amount of water carried by the aqueducts depends upon the value given to the *quinaria*, the official unit of measure, explained by Frontinus, who, as *curator aquarum* under Trajan, wrote a treatise upon the aqueducts. The most probable value* has recently been determined as 0.48 litre per second or 41.5 cubic metres in twenty-four hours; and we thus get the following table:

	Quinariae (Frontinus).	Litres per second.	Cubic metres per diem.
Anio Novus	4738	2274	196,627
Claudia	4607	2211	191,190
Marcia	4690	2251	194,365
Anio Vetus	4398	2111	182,517

There were no large clearing or settling tanks within the city, only comparatively small reservoirs (*castella*) from which distribution was made by lead pipes; and this is the case with the modern aqueducts also, so abundant is the supply.

The Romans, as we have seen, having at their disposal comparatively little theoretical knowledge of mechanics, they yet succeeded in achieving marvellous results, largely from their practical ability. They must have solved such problems as the transportation of an obelisk by the multiplicity of simple elements of traction employed and by the ingenuity displayed in their arrangement. When it is a question of sea transport, we cannot but admire the courage of those who succeeded in bringing such huge masses of stone through the Mediterranean from Egypt to Italy without the aid of steam—an even greater enterprise than dragging them along the land without the appliances that we now have at command. The study of practical engineering among the Romans shows us that in this, as in other spheres, they added very considerably to the sum of human achievement, and thus contributed in no small measure to make the condition of the human race what it is.

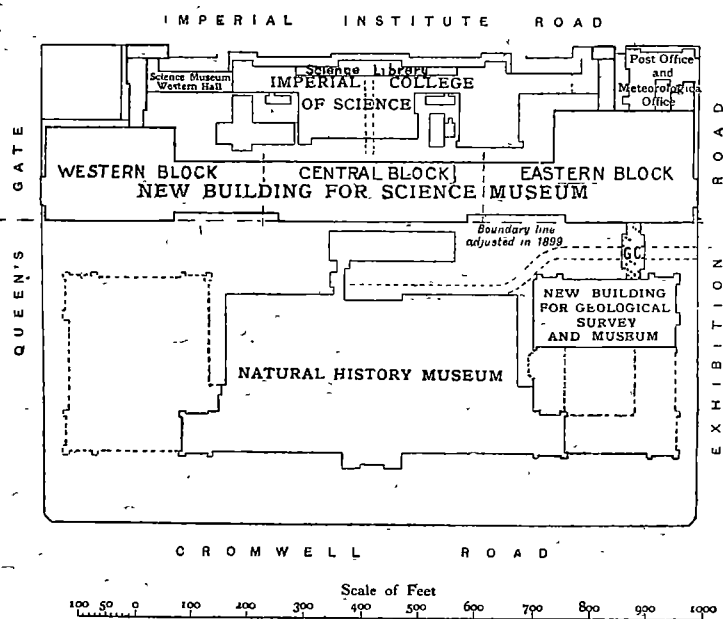
The Science Museum, South Kensington.

WORK has just been commenced on the eastern portion of the new Science Museum buildings in South Kensington, and by the spring of 1927 a handsome façade (Fig. 2) should have replaced the

plastered brickwork which has stood on the west side of Exhibition Road since the War.

Behind this east face, however, much has already been done, and a series of galleries on each of the four floors have been completed during the past three years to replace the Western Galleries on the north side of Imperial Institute Road, which were transferred to the Imperial War Museum in 1922. With the completion of the eastern front, which includes four galleries facing Exhibition Road, the first portion of the new Science Museum buildings will have been provided, following the recommendations of Sir Hugh Bell's Committee of 1911.

This Committee recommended¹ that the existing buildings, which had been originally erected for the refreshment rooms of the Exhibition of 1862, should be replaced by three main blocks with connecting galleries, to be erected on the existing site and to extend ultimately from Exhibition Road to Queen's Gate between the Natural History Museum and the Imperial College of Science. The eastern block, which is now nearing completion, will provide 100,000 sq. ft. of exhibition space, and so much of the connecting galleries as are in use, though not completely finished,



G.C. = Galleries connecting Science & Geological Museums.

FIG. 1.—Plan of museum buildings, South Kensington.

¹ H.M. Stationery Office, Cd. 5625 and 6221, 1911, 1912.

brings the total up to 135,000 sq. ft., or about one-third more than was available in 1912; but since then it has been necessary to allot more than 20,000 sq. ft. to the aeronautical collection and to that which illustrates wireless telegraphy and telephony. Up to the present, therefore, the exhibition space which will shortly be available is only about half of what the Committee of 1911 considered to be immediately necessary, so that the construction of another block, to provide about 110,000 sq. ft., is already an urgent need, and this would bring the available accommodation about up to the Committee's recommendation; the old buildings which it would replace are constructed with wooden floors, staircases, etc., so that the risk of fire in them is great, and should a conflagration occur, practically nothing of the important naval and shipping collections which they now contain could be saved.

The provision of the third block, which will face Queen's Gate, would, in the opinion of the Committee,

lines of a storehouse of all that relates to advance in science and technical industry, would require accommodation far in excess of that which is likely to be available. The policy, therefore,² which has been adopted is to show for each group such a critically selected series of objects as will illustrate all important stages in the development of a group, and to exhibit also a number of examples to represent the current practice of to-day. But even this is difficult with the existing accommodation, and several groups are still inadequately represented.

In the series which illustrate historical development, examples of early mechanical and scientific apparatus which have been designed, constructed, or used by pioneers in various branches of science and technology are not only of great historical interest, but are also most stimulating to those who visit the Museum and study its collections. Among the more recent acquisitions several are of this kind, for example, the

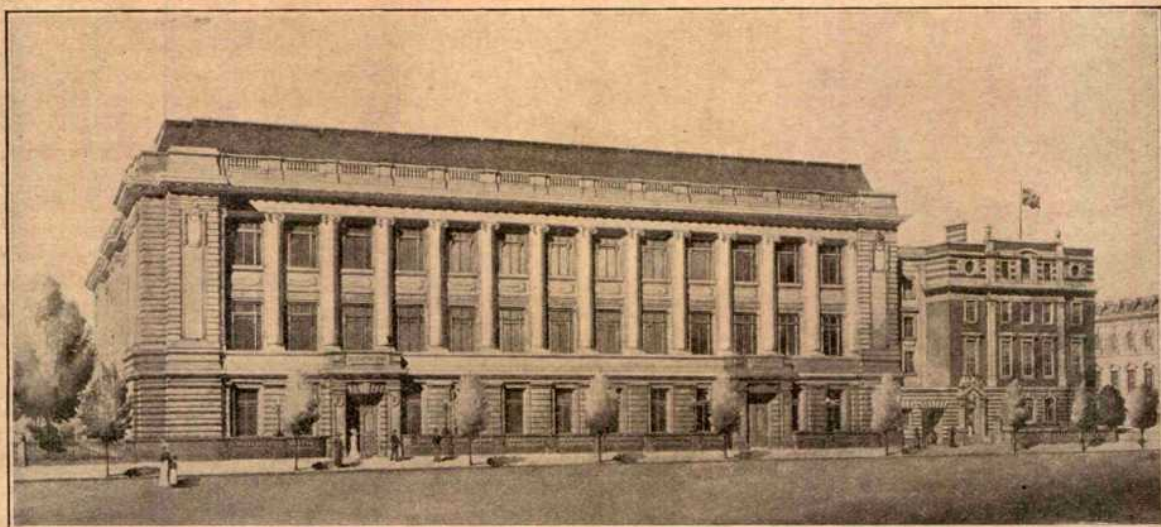


FIG. 2.—The Science Museum, South Kensington, when completed.

be needed later for the development of the collections or in consequence of an extension of the scope of the Museum, but not for several years.

For the present, the galleries in the eastern block which have been completed are being utilised to accommodate the collections which were exhibited in the galleries now occupied by the Imperial War Museum, that is, those illustrating physical science, mining and metallurgy, and some which have been long in store for lack of exhibition space; others have been moved there to allow more space for the aeronautical collection which is being developed rapidly. But in every case only a selection from each collection can be exhibited, since the space which is or shortly will be available is insufficient to do more than this.

The scope of the Science Museum as formulated by the Committee of 1911 is "to afford illustration and exposition of the various branches of Science within its field, and of their applications in the arts and industries," which is a very wide definition, as it includes the illustration of current practice as well as the preservation of objects of historical interest; so wide indeed is it that to develop the Museum on the

contents of James Watt's workshop, Henry Maudslay's screw-cutting lathe of 1810, Hughes' microphones of 1878, Prof. Fleming's thermionic valves (1889-1904), and early wireless apparatus lent by the Marconi Co. These and many others furnish starting-points of special interest from which history of the groups to which they belong can be studied.

In various parts of Great Britain there must be many other objects of a similar character which might be with advantage presented or lent to the Museum for exhibition, if only to guard against the risk of them passing into the hands of those who may be ignorant of their historical importance and may therefore dispose of them, when they are usually lost sight of. The historical value of what has already been lost to the history of science in this way is incalculable.

The present arrangement of the collections is only temporary, being determined by existing conditions, and by the need for exhibiting the science collections which have been for the most part stored during the past three years. When another block of the new

² Report on the Science Museum for the year 1923 H.M. Stationery Office, 1924.

buildings becomes available, more satisfactory arrangements can be made, and collections which can now only be shown in part will be more adequately represented.

The ground floor contains the more important objects illustrating prime movers, and locomotive

his machines, tools, etc., as they were at his death in 1819; its position within sight of three of the engines designed by him and built at Birmingham towards the end of the eighteenth century is especially appropriate.

The rest of the ground floor, the west gallery which is to connect the eastern with the centre block, contains part of the collection illustrating aeronautics. Here are models of the early machines of Henson and Stringfellow, Wright's aeroplane of 1908—the gliders of Lilienthal, Chanute, and Weiss, Maxim's flying machine and other objects illustrating the pioneer period of aviation. A collection of some fifty aeroplane models shows the strikingly rapid development of the heavier-than-air machine during the War, culminating in the Vickers-Vimy Rolls-Royce plane which was flown across the Atlantic by Sir John Alcock and Sir Arthur Brown in 1919. A large collection of aero-engines, many of them sectioned, is also shown here. The aeronautical collection has now extended into two adjoining rooms of the old buildings, where the structure of aircraft is illustrated; Roe's interesting triplane of 1907 is also here. Aeronautical instruments of all kinds are shown in the wall cases.

The aeronautical collection includes that of the Imperial War Museum, which has been lent by the trustees of that institution, and the combined collections form an exhibit of air transport which is more complete

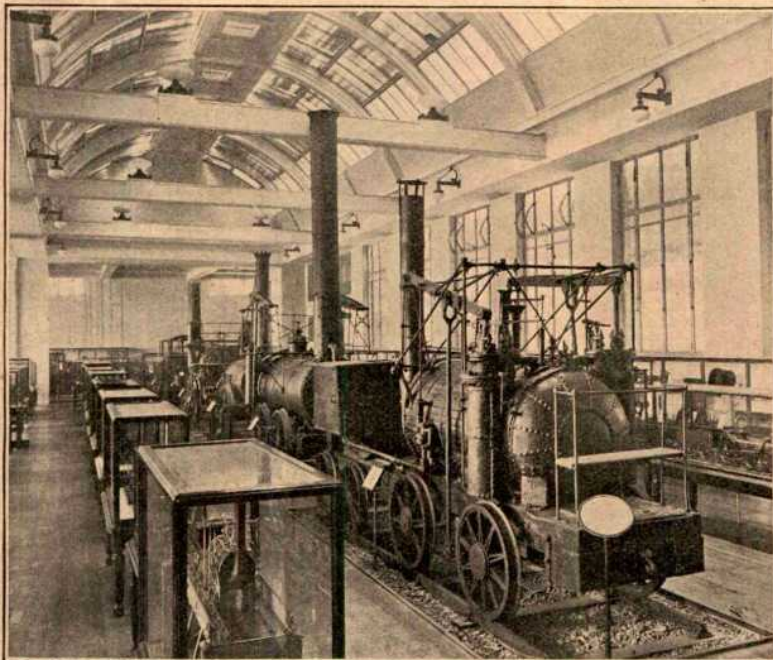


FIG. 3.—North hall, ground floor, Science Museum, South Kensington. Locomotive Collection.

engineering. Six early pumping and rotative engines of great historical interest are placed on either side of the main hall, the atmospheric engine from Pentrich Colliery (1791), the Old Bess pumping engine by Boulton and Watt (1777), and Heslop's beam engine (1795) on the left, with Boulton and Watt's rotative engines of 1788 and 1797, together with a rotative beam engine of about 1820 on the right. Models of the principal types of stationary engines occupy the wall cases, while others of windmills, water power installations, etc., are in the south gallery. Such internal combustion engines as are not shown in connexion with aeronautics or motor transport are also exhibited here. On the north side of the floor, the four early locomotives, the *Puffing Billy*, the *Agenoria*, the *Rocket*, and the *Sans Pareil*, are arranged down the centre of the north hall, with models of many other types of locomotives on either side (see Fig. 3). This gallery was originally designed for special exhibitions in which various groups would be shown more fully than could be done in the normal collections, but this use of it has to be postponed until the locomotives can be accommodated elsewhere. At the end of this hall is the reproduction of James Watt's attic workshop at Heathfield, Birmingham, showing all

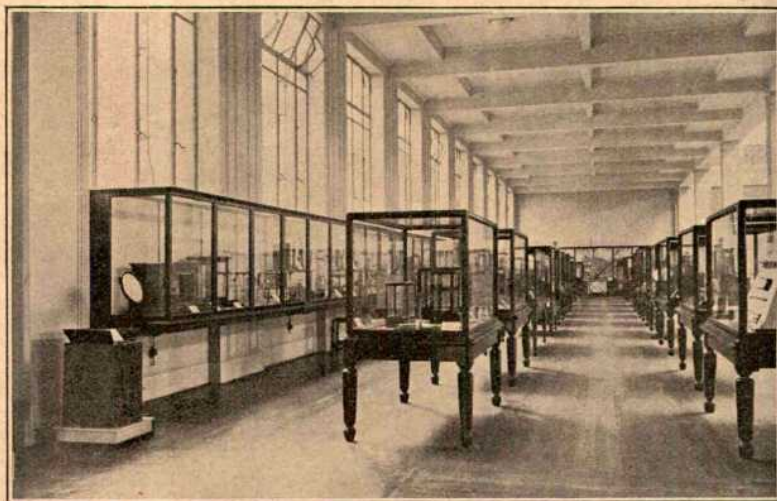


FIG. 4.—Centre gallery, first floor, Science Museum, South Kensington.

and important than any other in existence; the full-size planes and some other of the larger exhibits have for the time being to be placed in the basement, where they are available to visitors, but it is hoped that later on the collection may be shown as a whole.

The first-floor galleries will before long be connected

by a bridge with the new Geological Museum which is about to be built alongside the Science Museum to receive the collections which are now in Jermyn Street, and the Office of the Geological Survey. In these galleries, therefore, so much of the collections illustrating mining, ore-dressing, and metallurgy are being arranged as can be shown there (Fig. 4). The north gallery on this floor will contain the valuable collection of textile machinery which has been in store for several years. Tools and machine tools are shown in the western cross gallery, where the development of certain selected tools, such as the axe, drill, hammer, etc., from the times of the earliest civilisations to the present day, form interesting and instructive exhibits. In the gallery which connects this floor with the old buildings, the collections of electrical engineering and of telegraphy, telephony, and radio communication are being arranged.

The upper floors of the eastern block are being utilised for the exhibition of the collections of scientific apparatus, which were formerly in the galleries on the north side of Imperial Institute Road. Of these the following are being arranged on the second floor: mathematical, electrical, thermal, and acoustical instruments, while the north gallery will contain the geophysical collections of meteorology, seismology, gravity instruments, and terrestrial magnetism. In the western gallery, which will later on connect this floor with the centre block, will be the collection of pumps, and also that which illustrates engineering construction, and certain aspects of municipal engineering which are

now being developed. On the third floor the collections of astronomical and optical instruments will be shown, as well as those illustrating geodesy, surveying, cartography, geography, and oceanography, so far as the space allows. The western gallery of this floor has been allotted to chemistry and industrial chemistry, and these collections are being actively developed.

The naval and marine collections will still remain in the old buildings (the southern galleries). Many additions have recently been made to these, especially in the section of boats and small craft. Mechanical road transport will shortly be arranged in the western hall near to the Imperial Institute Road entrance.

The great superiority of the new galleries in their arrangements, the lighting, and generally in the facilities for exhibiting the collections to the best advantage, will be apparent to every visitor. The wall cases do not extend to floor level but stop at a height of 2 ft. 6 in. from it and are carried up to a height of 7 ft. By this means the whole of the contents are comfortably within the visitor's view, and the ineffective display of objects at ground level is avoided (Fig. 4). Channels in the floors carry electricity, compressed air, and gas to all the galleries for use in the demonstration models, and the number of these which are shown in motion or which can be operated by the visitor is being largely increased. Seating accommodation for visitors has not been overlooked, and the need of students in this respect who may wish to examine objects in detail, and to make notes, has been met by placing portable stools in each gallery.

Obituary.

SIR FRANCIS DARWIN, F.R.S.

A SON who follows a famous father is apt generally to find himself in somewhat of the position of a sequel to a very popular romance, and that Francis Darwin stands prominently forth in the light of his own achievements is enough to show that in him we possessed a man of great distinction. Whilst he will probably remain best known as the author of his father's *Life*, much of his work in other lines has borne fruit. But to those who had the privilege of his friendship, he will always be a living memory on account of his very human personality, his great kindness of heart and ready sympathy, and his extraordinary personal modesty. The writer well remembers his astonishment, when first attending Darwin's lectures, at his frequent confessions of ignorance (shared, of course, even if not admitted, by all other physiologists) upon this or that point that was under consideration. This, though to-day a more common frame of mind, was less customary at that time, when the teacher usually strove to make a more or less completely rounded presentation of his subject, avoiding the unknown or the little understood so far as was conveniently possible.

Educated at Clapham Grammar School and at Trinity College, Cambridge, where he obtained a first class in the Natural Sciences Tripos, Darwin afterwards went to Würzburg to study under Sachs, as did so many of our most capable men at that time. He afterwards graduated in medicine, but never practised.

Francis Darwin's earliest published paper appeared in 1872, during the time of his medical study at St.

George's Hospital. It was a conjoint paper with the prosector at the Zoological Society's Garden, describing the anatomy of an ostrich which died of copper poisoning through the ingestion of "two pennies and fifteen halfpence." Then followed in 1876 the publication of his M.B. thesis on the causation of vascular dilatation in acute inflammation, which records experiments carried out under Dr. E. Klein at the Brown Institute in London.

During the next few years Darwin worked at Down, where for eight years he acted as his father's secretary, and assisted him in much of his work. More especially was this the case in Charles Darwin's researches into the movements of plants, the well-known book upon this subject appearing in 1880 under the joint names of Charles and Francis Darwin. Two years later the latter was elected a fellow of the Royal Society, and when his father died in the following year he removed to Cambridge, where, except for occasional absences in London and elsewhere during recent years, he resided during the remainder of his life, at first in one of the houses of the well-known "Darwinery" on the Huntingdon Road, and afterwards at 10 Madingley Road.

University lecturer in botany from 1884 until 1888, and reader from 1888 until 1904, Francis Darwin had much to do with the complete reorganisation of the Botany School that then went on, especially when from 1892 until 1895 he was deputy for Prof. Babington. He devoted the stipend to the improvement of the teaching in various departments of the subject, while he himself

gave his time to teaching and research in vegetable physiology. The results of his experience in this direction appear in the well-known manual of "Practical Physiology of Plants" by himself and the late E. H. Acton, published in 1904; and he also brought out a stimulating work upon the "Elements of Botany," designed for the medical course in elementary biology. Though not what would be called an eloquent lecturer, Darwin always aroused great interest in the subjects that he taught, and by his great kindness of heart, by his clear understanding of the difficulties of a student, and by the minute and painstaking care that he devoted to their explanation, he won the affectionate esteem of many generations of undergraduates.

During this period Darwin published his first paper on the transpiration of plants, and so entered the field which was to include his major experimental work. In this paper, with R. D. Phillips (1885), he introduced his own particular form of the potometer for measuring the rate of uptake of water by a cut shoot so expeditiously that several readings might be taken within a minute. In 1893 there followed an attractive piece of work upon the growth of large gourd fruits, recorded by a weighing mechanism designed by his brother Horace Darwin. This demonstrated the extent to which the fruit, on the plant, might actually lose weight when the leaves associated with it were transpiring water actively. In 1897 he described a quite new instrument—the horn hygroscope—for investigating the rate of transpiration from living leaves. This ingenious device made use of the strong curvature of a shaving of horn when one side is exposed to more humid air than the other. It can be applied to leaves on the plant with the minimum of disturbance; and Darwin's big paper of 1898, entitled "Observations on Stomata," contains an extensive study of the effect of external conditions on the rate of transpiration made with this hygroscope.

In 1911, in association with Miss D. F. M. Pertz, Darwin described yet another simple instrument for studying transpiration. His porometer measures, not the water vapour given off from the leaf, but the openness of the stomata, since it determines the rate at which air can be drawn through the pores of the stomata under a standard suction. It can be attached to leaves upon the plant; and it has been widely used by subsequent investigators.

The other field of physiology in which Darwin specialised may be considered as an extension of his early studies at Down on the movements of plants. He published a certain amount of experimental work in support of the localisation of sensitiveness to the factors producing curvature of growing organs, and he was a staunch exponent of the statolith theory of "geo-perception."

Darwin's greatest service to science, perhaps, was the "Life and Letters of Charles Darwin," a biography which may rank with the best that have ever been written. It gives the clearest possible picture of Charles Darwin as a man and as an enthusiastic student of science, tracing in a masterly way the gradual development of his views upon evolution and upon other subjects, while at the same time keeping the actual author of the work in the background, and leaving his character to be traced only from the general style, and the occasional references in letters. A con-

tinuation, or expansion, of this work was later published as "More Letters of Charles Darwin" by Francis Darwin and A. C. Seward.

President of the British Association at Dublin in 1908, Darwin devoted his address to the subjects of his own researches, especially bringing forward his since little accepted hypothesis of unconscious memory or habit in the development of plants and their movements. He received honorary degrees from his own University and also from St. Andrews, Dublin, Liverpool, Sheffield, Brussels, Upsala, and Prag. He served twice upon the Council of the Royal Society, and was its foreign secretary from 1903 until 1907, and vice-president 1907-8. He was knighted in 1913. A keen musician, and a kindly host with a strong sense of humour, Darwin was regarded with affectionate respect by great numbers of people.

MR. F. J. BRODIE.

MR. F. J. BRODIE, who entered the Meteorological Office in April 1869 and retired in December 1919, after fully fifty years' service, died on August 29 in his seventy-third year. He was principal forecaster for many years, and was essentially a forecaster of the old type, basing his predictions strictly on past experience, with a thorough grip of weather changes and their controlling features, whereas the present-day forecasters work on a somewhat more strictly scientific basis.

Mr. Brodie was for many years an active fellow of the Royal Meteorological Society, and he contributed numerous papers to the Quarterly Journal of the Society, dealing chiefly with fogs and gales; "Prevalence of Fog in London, 1871-1890," and "Prevalence of Gales over the British Isles, 1871-1900," being of especial importance. He was a prolific worker and writer, communicating regularly to *Symons's Meteorological Magazine*, now the *Meteorological Magazine* issued by the Air Ministry. He was the principal forecaster throughout the War, the period involving much responsibility, and the especial duties required were at times ill supplied with necessary meteorological data, and under such conditions Mr. Brodie's long training and experience were of the utmost value. He continued his official position until two years after the age limit. Mr. Brodie's health failed considerably during the last two or three years of his life. He was greatly respected by his colleagues, and many who were associated with him in the early days of the Meteorological Office, as well as those working with him in more recent years, can testify to his amiability of character and his willingness at all times to help forward the development and better understanding of meteorology.

WE regret to announce the following deaths:

Prof. A. A. Friedmann, Director of the Central Geophysical Observatory of Russia, on September 16, aged thirty-seven years.

Prof. Andrew Gray, F.R.S., emeritus professor of natural philosophy in the University of Glasgow, on October 10, aged seventy-eight years.

Dr. C. F. Sonntag, prosecutor to the Zoological Society of London, on October 10, aged thirty-seven years.

Current Topics and Events.

THE City of Gloucester proposes to commemorate the achievements of Sir Charles Wheatstone, the practical founder of telegraphy, by placing a bronze memorial tablet on one of its public buildings. This will be unveiled by Sir Charles Sherrington, president of the Royal Society, on October 19, which is the fiftieth anniversary of Wheatstone's death. To electricians, Wheatstone will long be remembered as the perfecter of the "Wheatstone bridge" which they use in their everyday work. In 1867 he described the self-exciting, shunt wound dynamo. They remember him also as the pioneer of the electric telegraph. So far back as 1837, in conjunction with Sir William Cooke, he made the electrical transmission of messages an assured success. In 1844 he conducted some of the earliest experiments in submarine telegraphy. To physicists Wheatstone is well known by the use he made of a rotating mirror to detect whether an electric discharge was oscillatory or not. He made valuable researches in sound, particularly in connexion with Chladni's figures and for his experiments on the prismatic decomposition of the electric light. In 1837 he made the important discovery that sparks between metals gave distinctive spectra. Wheatstone had a marvellous gift for interpreting documents printed in cipher. He deciphered with apparently little difficulty an important document sent him by the Trustees of the British Museum. He invented the Wheatstone's cryptograph, which is one of the most successful devices for rapidly coding and decoding secret messages. The ordinary English concertina was invented and patented by him in 1829. He was a professor at King's College, London, for many years and bequeathed to it all his scientific library and apparatus. This bequest was added to by his family and also by the Physical Society of London. An article on his connexion with the growth of telegraphy was published in *NATURE*, vol. II, p. 510 *et seq.* It is interesting to remember that Oliver Heaviside, whose death we had recently to deplore, was his nephew.

DR. ALEŠ HRDLÍČKA in the course of his lecture on "Early Man" before the Royal Anthropological Institute (see *NATURE*, October 10, p. 557) expressed a fear that the important work on the fossil apes of the Siwalik Hills might not be continued. In a statement published in the *Times* of October 7, Dr. Pilgrim, director of the Geological Survey of India, stated that although the Geological Survey in a country like India must be subservient to economic requirements rather than to those of pure science, there is at present an exceptional opportunity for combining the two, owing to the discovery of oil in the fossiliferous deposits of the Punjab. This statement will reassure those in Great Britain who are interested in the advancement of science, as they have regarded recent developments in India with some apprehension, lest changing conditions may lead to a neglect of those branches of research in which immediate advantage is not always apparent. The danger of the neglect of opportunity which Dr. Hrdlička feared in India

is also very real elsewhere. He referred to the material, possibly of priceless value to science, which is being lost beyond recovery in Java on the site of the discovery of *Pithecanthropus erectus*. According to information which has been received from Australia, the situation there also has some disquieting elements. It is stated that under recent regulations all skeletal remains of aborigines which may be discovered there have to be deposited in local museums. It is therefore impossible for specimens to be sent out of Australia for study by anthropologists elsewhere. This, though serious enough, might be regarded as a not entirely unreasonable requirement on the part of the Australian authorities if there were some assurance that these remains would be carefully preserved and stored, their provenance recorded, and that after careful study the data to be obtained from them were published and made accessible to other workers. Apparently, however, this is not the case. It is surely incumbent upon scientific workers in Australia to see that provision is made for this to be done. It should certainly be taken into account when an appointment is made to the recently founded chair of anthropology.

SOME interesting particulars have reached us of an exhibit which has been arranged in the new house at the Royal Botanic Gardens, Kew, for the display of plants of special interest. One portion of the exhibit shows various examples of phyllodes and phylloclades illustrated by different species of Acacias, which, instead of the normal leaves, have the leaf petiole flattened and leaf-like. The leaves proper are usually only seen in seedling plants, the green leaf-like organs of the mature plants being entirely flattened petioles. This condition of affairs is also exhibited by *Oxalis bupleuroides*, and in this case the three normal leaflets may be seen at the tips of the phyllodes. In some other plants the leaf-like organs are flattened shoots, and these are illustrated by the common Butcher's Broom, *Ruscus aculeatus*, and by *Semele androgyna*. These phylloclades or flattened branches are also shown by species of *Asparagus*, *Carmichaelia* and *Phyllocladus*. Other plants displayed in this house show examples of "parallel development" in plants belonging to unrelated natural families. Those which have assumed an Ericoid habit with leaves of a heath-like character are shown by a heath, by *Fabiana*, one of the Solanaceæ, by *Gamolepis*, one of the Compositæ, and by *Calythrix*, a member of the Myrtaceæ. Near these are placed some specimens with a cypress-like character of foliage illustrated by a *Crassula* and a New Zealand *Veronica*. The various Cactoid types of growth are shown by species of *Pelargonium*, *Vitis*, and *Rhipsalis*, one of the true Cactaceæ, while larger specimens are illustrated by one of the South African *Euphorbias* and one of the candelabra-like Cacti from Central America. The Cactoid habit is also shown by a *Senecio*, one of the Compositæ, and by an *Asclepiad*, *Stapeha hirsuta*. The spherical type of plant structure is exhibited by a South African

Euphorbia, *Euphorbia obesa*, and by representatives of South American Cacti.

IN his address to the French Association for the Advancement of Science at Grenoble in July, the president, M. Emile Borel, dealt with the problem of the organisation of scientific research in France. Every one now recognises that the social progress of a nation depends on its use of the laws which facilitate the production of the means of living. A smaller band sees that the greatest material advances have been founded on discoveries made by research workers in fields which at the time seemed of little or no practical interest, and the problem of how to keep alive this type of research when democracy can only appreciate results which are immediate and material is a serious one. M. Borel considers it cannot be solved by allowing the academies and other institutions to determine the researches which are to be encouraged by the nation, or by providing national support for all research workers, but by placing in the hands of the academies, universities, institutions like the Association for the Advancement of Science, and of distinguished men of science, funds for the encouragement of young men who are willing to engage in research and are worthy of support. Some of these men would prove worthless, but M. Borel would apply to them the old axiom of law that "it is better to acquit ten guilty than to condemn one innocent." The address is reproduced in the issue of the *Revue Scientifique* for August 22.

IN accordance with resolutions passed at a preliminary representative meeting, held at the suggestion of the Optical Society on July 21, arrangements to hold an Optical Convention in 1926 are now being made by the executive committee appointed for that purpose. Mr. F. Twyman has been elected chairman of the committee. The Convention, which will be entirely British in character, will be held in London about the middle of April next. Its activities will be directed towards providing a coherent presentation of the very notable advances which have been made in British optics during and since the War. Lectures, discussions, demonstrations and exhibits will be arranged, and it is intended that these shall be of such a nature as to appeal to professional men, to those engaged in industries, and to the general public. A record of the proceedings of the Convention will be published, in which will be included an account of the papers read and the discussions held, together with a description of the instruments exhibited. Although no general appeal for financial support has yet been issued, promises have already been made, by several members of the optical industry and by the Optical Society, to contribute to the Guarantee Fund sums which amount, in all, to more than 1000*l*. This may be taken as an indication of the interest that is being taken in the proposal, and suggests that adequate financial support for the Convention will be forthcoming.

AN interesting feature of the September issue of the *Aeronautical Journal* is a paper by R. A. Frazer submitted for the R. 38 Memorial Prize Competition and

awarded the prize. It is entitled "The Rigid Airship in Relation to Full-Scale Experiment" and deals not merely with the experimental methods that have been evolved specifically to cope with scientific experimentation on such a large scale, but also with many interesting historical details relating to early struggles to arouse interest in this form of investigation. The driving force, it would appear, behind much of this work in its initial stages was J. R. Pannell, one of the members of the staff of the National Physical Laboratory at Teddington, who lost his life in the R. 38 disaster over the River Humber. Among the equipment salvaged from the wreck were three note-books comprising all the entries made by the N.P.L. representatives, and a film registering the pressures over the upper rudder practically up to the moment of the disaster. From the material which came to hand in this way it was found possible to reconstruct the principal stages and episodes of this dramatic flight. The experimental observations proved sufficiently complete to admit of reduction, and these data, which cost so many valuable lives, are now on permanent record in a paper published by R. A. Frazer and H. M. Bateman, one of the survivors of the disaster.

IT is a question how far the public in general is aware of the excellent work which is being done by the London County Council in stimulating the interest of its teachers in those scientific and artistic subjects which fall outside the scope of the ordinary curriculum, but are of incalculable value as a broadening influence on their intellectual outlook. Among the courses of lectures which have been arranged from time to time, the anthropological and biological courses given at the Horniman Museum, Forest Hill, which is maintained by the Council, have been particularly useful. This museum has been arranged especially with a view to the instructional value of its exhibits, and an excellent series of handbooks has been compiled by the curator, Dr. H. S. Harrison. These are written on thoroughly sound and scientific lines, but at the same time are not too technical to be of assistance to those whose scientific knowledge has not reached a very advanced stage. The latest issue in this series deals with the cases in the museum illustrating simple means of travel and transport by land and water (Horniman Museum, Forest Hill, S.E., No. 14, 1925, price 6*d*.). As the museum is liberally supplied with models, Dr. Harrison has been able to cover the subject adequately from the simple application of man or woman power by means of the headband or pack to the various types of wheeled transport, and from the skin canoe to the sailing ship.

CAPT. ECKERSLEY recently broadcast the main results arrived at by the International Radio Conference which has just been held at Geneva. The results of the tests made in September proved conclusively that Europe has too many broadcasting stations. This is mainly due to the narrow limit of the wave band (300 to 500 metres) that has been allotted by the European governments for broadcasting purposes. As government, maritime and commercial radio services must be considered, it is

unlikely that longer wave-lengths will ever be permitted. The majority of the experts therefore were in favour of reducing the number of broadcasting stations. To accomplish this, every nation must be prepared to sacrifice some of its stations. A few well-designed high-power stations will probably give better results than many low-power stations. If this were done the crystal set users would get a better service. It can be so arranged that these high-power stations cannot interfere with one another. An objection might be raised that certain towns would lose their broadcasting status and that the programmes they receive would have little local colour. This difficulty might be overcome by retaining the local studios in those towns and allowing them to give regular programmes by means of land lines to whatever station had charge of their district. The new scheme, which begins on November 1, will only come into operation gradually. It was absolutely necessary to attempt to mitigate the troubles caused by interference which would have caused a chaotic state of affairs during the coming winter. Details of the scheme will be announced as they are finally arranged by the permanent staff at Geneva. New stations outside the scheme will be given wave-lengths below 200. The new Dublin station, which will begin operations this year, was fortunate to be allotted a wave-length in the regular broadcasting wave-band.

A CIRCULAR issued by the Bureau of Standards, Washington (No. 276), contains a useful survey of progress in the design of motor headlights. Tests conducted by various committees have led to the conclusion that for modern driving it must be possible to see any substantial object on the road 200 feet away. This involves a powerful beam and inevitably some degree of dazzle to approaching persons. The most hopeful solution lies in the scientific control of the beam, and various optical devices for limiting it below a horizontal plane 30 to 40 inches above the roadway are described. In addition it is desirable to spread the beam laterally so as to show up the limits of the roadway. Various dimming devices, involving diminution of the light, have not proved very satisfactory. Methods of controlling the beam are more hopeful, e.g. devices for tilting the headlight or reflector so as to direct the beam downwards when approaching another car. The same result is obtained in some modern headlights by the use of either of two filaments within the same bulb, one out of focus. In the final portion of the circular, requirements for headlights are summarised, and the method of testing in the Bureau of Standards laboratory is described. These tests are based mainly on specifying candle-power in various directions with the view of ensuring a sufficient beam for driving, and at the same time limiting emission of light in undesirable directions.

A SUMMARY of the past season's work at Knossos is given by Sir Arthur Evans in the *Times* of October 9. In the course of completing the reconstitution of the west wing of the Palace, a series of discoveries of exceptional interest throw a new light on the entrance

system from the west and at the same time link up its processional scheme of decoration with the religious functions of the Palace Sanctuary. According to the earliest planning, belonging to the great building preceding and partly incorporated in the Palace we know, the entrance had run in directly from the west instead of from the south as in the later building. This West Porch was itself preceded by an earlier structure giving into a corridor, of which the side walls have been traced. In a void where the old foundations had been grubbed up were found stucco fragments which had been torn from the wall. These fragments showed a decoration of painted groups of seated female figures engaged at their toilet. It has been suggested that the decoration of the later corridor, which replaced this earlier passage after the greater part of the Middle Palace had been destroyed by earthquake, represented not only processional votaries bringing in gifts to the goddess, but also acolytes carrying out relics from the inner sanctuary for public exhibition in the presence of the "Priest-King." This has received unexpected support from a discovery in the South Propylæum which has brought to light a subterranean depository choked with debris and pottery of the last Middle Minoan period. Abundant remains of painted stucco show that its interior had been decorated in a deep Venetian red ground with ochre bands grained with ruddy brown to imitate woodwork. This Sacristy within the Propylæum may have been the sanctuary from which the sacred vessels were taken out to be borne in procession. Remains of brilliantly polished stone plaques with marble-like surface indicate the splendour of the Early Palace entrance which it was attempted to reproduce in the Later Palace in stucco.

IN 1875 the Bradford Naturalists' Society, now the Bradford Natural History and Microscopical Association, and also the Bradford Scientific Association were formed in Bradford. With varying fortunes both societies have continued active in the cause of natural history and of science, and on September 25 and 26 they joined in the celebration of their jubilee. The Lord Mayor honoured the two societies by a civic reception at the Cartwright Hall on September 25, and on September 26 a most successful exhibit and demonstration of the scientific work of the members was held at the Technical College in Bradford. Under the title of "Fifty Years of Local Science" an interesting account of the work of the two societies has been published under the joint editorship of H. J. M. Maltby and W. P. Winter, which includes brief notes of many stalwart Yorkshire workers in the cause of natural history, notably the late William West, whose influence upon natural history, radiating from his classes at the Technical College at Bradford, will long remain a living force in the development of clubs of Yorkshire field naturalists.

WE much regret to learn that Prof. H. Maxwell-Lefroy, professor of entomology, Imperial College of Science and Technology, South Kensington, was rendered unconscious by fumes while experimenting with insecticides in his laboratory on October 10 and was taken to hospital in a serious condition. In

answer to an inquiry at the moment of going to press, it was stated that he was still unconscious and his condition remained grave.

MEMBERS of the staff of Rothamsted Experimental Station, Harpenden, Herts., are available for lectures during the winter to farmers' unions, chambers of agriculture, agricultural societies and similar bodies. No charges are made, but associations are expected to defray the lecturer's expenses. The subjects for lectures are included under such general titles as manuring, soil micro-organisms, weeds, chemistry of manuring and crop production, soil physics, insecticides and fungicides, insect pests, bees, and plant diseases. Communications regarding the lectures should be addressed to the secretary of the Station.

THE annual exhibition of electrical, optical, and other physical apparatus arranged by the Physical Society of London and the Optical Society is to be held on January 5-7, at the Imperial College of Science and Technology, South Kensington. In addition to the usual display by instrument makers, the exhibition this year will include new features in the shape of illustrations of recent physical research and of improvements in laboratory practice, examples of effective lecture experiments and repetitions of historical experiments in physics. These exhibits will be kept distinct from the trade exhibits, and a section of the catalogue will be devoted to them. Offers of such exhibits should be sent to the secretary of the Physical Society at the Imperial College of Science not later than November 16. The new development will afford an opportunity for the interchange of ideas between research workers and teachers, and will also be of service in bringing the

latter into touch with recent advances in physical science. The repetition of historical experiments will be of interest not only to teachers but also to the general public, who will be admitted to the exhibition on January 7. This is another novel feature, admission to the exhibition in previous years having been confined almost entirely to scientific workers.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: An assistant lecturer in agriculture at the Farm Institute, Spars-holt, near Winchester—The Director of Education, The Castle, Winchester (October 26). A demonstrator in inorganic chemistry in the University of Leeds—The Registrar (October 26). A lecturer in the department of chemistry of the University of Cape Town—The Secretary to the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (October 27). A professor of botany in the Rhodes University College, Grahamstown—The Secretary to the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (November 4). Assistant-Secretary to the Royal Society of Arts—The Secretary, John Street, Adelphi, W.C.2 (November 7). An editorial assistant under the British Non-Ferrous Metals Research Association, for abstracting and reviewing British and foreign scientific and technical publications and for editing and interpreting research reports—The Secretary, B.N.F.M.R.A., 71 Temple Row, Birmingham. Two male junior assistants in the research department, Woolwich, for computing work in connexion with ballistic observations—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

ANOTHER FAINT NOVA IN AQUILA?—Prof Max Wolf recently detected a star of magnitude 8.7 in Aquila, which was absent both from the Bonn Durchmusterung and from numerous photographs taken in recent years at Königstuhl, which show stars down to magnitude 12 or 13. It has been in the neighbourhood of mag. 8.7 for about three weeks, and was observed on Oct. 3 by Mr. B. M. Peek at Bournemouth and on Oct. 5 by Mr. G. Merton at Blackheath. Its place for 1925.0 is R.A. $19^h 27^m 24.7^s$, S. Decl. $6^\circ 35' 10''$. It is either a Nova or a remarkable variable, and in either case deserves careful observation. The object souths at about 6 P.M., so it will be possible to follow it for at least two months before it gets too near the sun for observation.

BRIGHT METEORS.—Mr. W. F. Denning writes that, on the evening of October 6, meteors were rather abundant though fog prevailed and the gibbous moon was up during the latter part of the observation. Meteors are often plentiful in the first week of October, several minor showers of moderate richness being of annual recurrence at this period. A few bright meteors were among those recorded on October 6 at Bristol, namely, one at $19^h 39^m$ G.M.T., equal to Jupiter, passing upwards just under Cassiopeia from a radiant at $14^\circ + 31^\circ$ or $12^\circ + 7^\circ$, another at $21^h 0^m$ G.M.T. falling in the S.E. sky rather slowly from $18^\circ + 14^\circ$ to $33^\circ - 10^\circ$. This was brighter than Venus and probably directed from a radiant in Cygnus, Cepheus, or Draco. A third at $21^h 56^m$, about

equal to Jupiter, shooting from near α Ursæ Minoris to between α and β Ursæ Majoris. If one or more of these objects were noticed at other places, it would be interesting to hear of any details of their apparent paths which would enable their actual courses to be computed.

ORBIT COMPUTING.—There is at present a dearth of readily accessible books in English that give full details of the rather difficult but fascinating problem of orbit computing. Students of celestial dynamics will therefore welcome the paper on this subject by Mr. G. Merton (Monthly Notices of Royal Astronomical Society, June 1925). The method described is based on that of Gauss, but full use is made of various improvements introduced since his time, including some by Mr. Merton himself. Special attention is given to rapid convergence, a point in which many of the older methods are defective, and to the avoiding of all unnecessary repetition after the first approximation to the geocentric distance is obtained. In particular, the parallax is eliminated in a less clumsy manner than that of Gauss's *locus fictus*. There are two fully worked out numerical examples, elliptical orbits being illustrated by the case of Baade's planet 1924 TD (lately named Ganymede) and parabolic ones by Orkisz's comet 1925 II. Some tables are appended to the paper, which avoid the necessity of consulting any other work, except a table of logarithms and the Nautical Almanac for the sun's co-ordinates.

Research Items.

CARVED STONES IN ASSAM—In vol. 20, New Series, No. 5 of the Journal and Proceedings of the Asiatic Society of Bengal, Dr. J. H. Hutton gives some further notes on two groups of carved menhirs in Assam, one at Dimapur in the Dhansiri Valley and another, which is scarcely known, at Kasomari-pathar near Jamuguri in the Dayang Valley. Adjacent to the latter are remains, previously undescribed, consisting of a couple of carved stones and a broad upright slab surrounded by the remains of a brick wall. One of the stones is carved into a hollow like a basin. Outside its rim is a trough ending in a spout. The second, an oblong stone, is carved into a wedge-shaped trough. The upright slab, at the foot of which a hollow has been excavated, is broken at the top at a point originally pierced by two round holes. As the basin must have been connected with a libation ceremony, it is possible that an offering was poured through the two holes as is done by the Angami to-day in the *hsu* ceremony at which wooden phallic symbols, corresponding to the monoliths at Dimapur, are erected. The Kasomari monoliths presumably are also phallic, or connected with fertility, as is shown by two pairs of domes on one stone which undoubtedly represent breasts.

ABORIGINAL ROCK PAINTINGS AND CARVINGS IN AUSTRALIA—In the course of an account of the aborigines of the Northern Flinders Ranges, Southern Australia, in Vol. 3, No. 1 of the Records of the South Australian Museum, Messrs. Herbert M. Hale and Norman B. Tindale describe some interesting rock paintings in a former native camping ground at Malkaia, six miles south-east from Mount Serle, and a series of rock carvings at Owicandana on a number of outcrops of sedimentary rock. The former, of which the designs sometimes recall those of the carvings, are on a cliff overhanging a shelf and forming a shelter, of which the walls are blackened with smoke from the occupants' fires. The paintings are in pipeclay, charcoal, and red and yellow ochre. The designs consist of perpendicular bars with branches, or crossing bars, a bird track, a meandering pattern possibly representing a snake, a figure which Basedow elsewhere identified as a pubic tassel, a boomerang, etc. The rock carvings are similar to those which have been described by Basedow in other localities in South Australia. They are covered with a hard dark rust-coloured patina and some have been smoothed by age. The present natives are unacquainted with their purpose or meaning. In the main they consist of "corroboree circles," incomplete circles, a few emu and other tracks, and some unidentified designs. Some, the circles for example, are formed by a number of closely connected indentations, possibly made with a stone chisel; others of inferior technique and possibly made with a cold chisel, look like comparatively recent, sporadic attempts to copy ancestral work.

FUNDAMENTAL WORK UPON THE COTTON HAIR—It is very striking to note that the development of fundamental research in the newly formed Research Association dealing with commercial fibres, be they wool, flax, or cotton, leads the investigators back to study their problems in terms of their fundamental biologic unit. This is again exemplified in the study of the mercerisation of the cotton hair without tension by Mary Alexandra Calvert and Frederick Summers, which has recently been published from the British Cotton Industry Research Association (Journal of the Textile Institute, vol. 16, pp. T233 to T268, August 1925). These investigators have shown how regular is the change of width of the single hair during

swelling upon mercerisation, in a number of typical cottons, and how fully this change can be accounted for in terms of the change from collapsed dry hair to a hair with swollen elliptical section, contracted in length and with lumen nearly filled by the swollen wall. Further, they show that no additional change in width can be produced by increasing the concentration of sodium hydroxide beyond about 16 per cent., and that the maximum width then obtained is identical with the width of the original hair as it existed in the fruit boll, contraction occurring as the boll opens and the hair dries. They show in addition that the reason for this limit to increase in girth must be sought in the cuticle, which fails to extend beyond its original dimensions in spite of the pressure of the swelling cellulose within. When the width of this mercerised hair afterwards shrinks, without change in the shape of the cross-section, as the hair is washed in water and then dried, this inextensible cuticle smoothly follows the contraction, and the authors have some very interesting suggestions as to the minute structure of the cuticle in the light of its behaviour. These suggestions are accompanied by some very good microphotographs. In fact, this study in a field of applied science is a botanical contribution of absorbing interest.

AN AUTHENTIC BUD VARIATION IN POTATO—So recently as 1918 so experienced a plant breeder as Mr. A. Sutton expressed the view that "there is no ground for believing nature ever has given rise to any new and distinct variety of potato by bud-variation." The point at issue is of first-rate importance, both scientifically and from the practical point of view, and it is therefore very interesting to have Mr. R. N. Salaman's confirmation, as the result of extensive breeding experiments, of Mr. McKelvie's original view that he had found an authentic bud sport turning up in the case of the Arran Victory potato. Thus sponsored, this bud sport, or somatic mutation, deserves the most serious consideration. Actually a series of such sports has been under observation, the obvious point attracting attention to them being the suppression of patches of the purple coloration in the skin, leading ultimately to a form with white tubers with occasional patches of colour, or, in the extreme form, tubers with a pure white skin. Most of the forms thus arising produce plants with vegetative form and foliage indistinguishable from Arran Victory, but one remarkable mutant has definitely a different growth form and different shaped leaflets, a point noticed by McKelvie and completely confirmed by Salaman. This same mutant also shows the tuber form altering in a large majority of its produce from the typical round tuber of Arran Victory towards a typical "kidney." Mr. Salaman has carried out crossing experiments with these bud mutations, with the result that the loss of pigment in the tuber appears to be accompanied *pari passu* with a reduction in the number of ovules capable of giving rise to coloured tubers. Thus it appears that a change arising in a vegetative shoot and propagated in the first place vegetatively, a change presumably in the genes controlling colour formation in the tuber but, in one mutant form at least, associated with other far-reaching changes in the constitution of the plant, has been associated with changes in the genetic constitution of the germ cells. Mr. R. N. Salaman describes his breeding experiments in the *Journal of Genetics* (vol. 15, No. 3, July 1925), his final conclusion being that "A somatic mutation which is characterised by the loss of a specific character such as pigmentation of the tuber skin, may evince this loss in other directions.

both in its own body and, through its germ cells, in its offspring."

MOVEMENT OF SAND CAYS.—A short report on the movement of sand cays on the Great Barrier Reef under the influence of atmospheric conditions is contributed to the *Queensland Geographical Journal*, vol. 39, by Lieut. T. Taylor, and forms one of the Great Barrier Reef committee's reports. Beaver Cay, on a small coral reef about 20 miles from Dunk Island, was used as a triangulation station in 1921. In 1922 the position was found to have moved. The position of the new mark was fixed, and after an interval of two months, during which high winds prevailed, was redetermined. Again it was found that the cay had moved. In short, there seems to be no doubt that this cay, as well as another three miles distant, moved approximately 100 yards in less than two years. The paper is accompanied by a chart of the reef and cays.

THE COMPTON EFFECT.—When γ -radiation falls on matter it is "scattered," that is, sent off in directions which make angles θ with its direction on incidence, and the scattered radiation is "softer," that is, more readily absorbed, than the incident. Two years ago Compton came to the conclusion that the scattering was accompanied by an increase of wave-length of the radiation which for a range from 0.7 to 0.025 Ångström units was equal to $0.048 \sin^2(\theta/2)$. He also gave an expression for the intensity of the scattered radiation in the direction θ which involved the term $1 + \cos^2 \theta$, basing his work on the quantum theory. In the issue of the *Physikalische Zeitschrift* for July 21, Dr. G. Wentzel discusses the experimental results obtained up to the present time and the alternative theories which have been proposed to explain them, and comes to the conclusion that the Compton theory is most in harmony with the facts.

CONTACT ELECTRIFICATION OF SNOW.—A series of experiments on this subject and some measurements are described by Dr. A. Stager in the *Annalen der Physik* for August. When hoar frost is blown away from an ice surface by dust-free air, it is negatively charged, one gram carrying on the average -180 electrostatic units, and in exceptional cases -1000 units. An experiment at the Hahnenmoos Pass in the Bernese Oberland, with icicles about 20 cm. long and 1 cm. thick suspended by silk threads attached to the two ends, showed that when they were hung in the drifting snow near the ground, and then brought into contact with a Lutz electrometer, deflexions of more than 56 volts were generally obtained, the charge being negative, when they were hung in the finer drifting snow one or two metres above the ground, the charge was generally positive and smaller than before. It was found that an iron wire, 9 metres long and 0.3 mm. thick, could be raised to a potential of several thousand volts by driving snow, and could give a continuous current for several seconds with about 3 watts power. The method used by the author in measuring the space charge during snowfalls is described, together with experiments with solid carbon dioxide and with different powders, in some of which luminous effects are obtained similar to those which have been observed in clouds of street dust. The experiments are used to explain winter thunderstorms, and the connexion of sleet and hail with ordinary thunderstorms where the ice effect, in addition to that due to liquid water, contributes to the production of electric charges.

RESISTANCE TO CORROSION OF ELECTROPLATED CHROMIUM.—Mr. F. A. Ollard read a paper on this subject before Section B (Chemistry) of the British Association, at the recent meeting at Southampton.

Two series of tests were described, one made in the laboratory and the other in service. The laboratory tests were made on test pieces cut from a strip of mild steel, which were then plated with cadmium, nickel, copper and chromium and combinations of these metals in various orders. The test pieces were then subjected to an exposure test, boiler test, salt spray test, and heat test, and the results noted. The most satisfactory results were shown by the test pieces which had been plated first with nickel and then with a thin layer of chromium. Test pieces plated first with cadmium and then with chromium showed a tendency for the chromium to flake off, and all test pieces containing cadmium failed badly under the influence of heat. The nickel-plated specimens usually showed a certain amount of surface corrosion, while the specimens in which the chromium was plated directly on to the steel usually failed owing to the coating being somewhat porous. Contrary to expectations, the chromium stood fairly well in the salt spray. The second series of tests were made by placing chromium-plated articles in service. Spoons, forks, and knives were treated by this process and used in various places under very heavy conditions, and these remained bright and untarnished without any cleaning. Also, some small parts on motor-cars, etc., had been plated and are standing very well, although sufficient time has not yet elapsed to give any definite results. A pin in a die-casting mould has also been treated and appears to withstand the action of the molten metal very satisfactorily. It is hoped to do a considerable amount of further work on this subject, and among the experiments to be tried are the effects of sea water and the variation of reflective power with ageing.

TUNGSTEN IN CONSTRUCTIONAL STEELS.—R.D. Report, No. 65, from the Research Department, Woolwich, gives an account of an investigation carried out by Mr. J. A. Jones on "The Influence of Tungsten on the Properties of Medium Carbon Steels containing Nickel and Chromium." The carbon varied from 0.3 to 0.4 per cent, nickel from 2.5 to 5.9 per cent, chromium from 0.6 to 1.1 per cent, and tungsten from 0.7 to 2.4 per cent. The thermal critical ranges, microstructure, and mechanical properties of a number of these alloys have been examined. The principal results are that in steels of otherwise identical composition increasing tungsten raises very slightly the temperature of A_{c1} . The rise amounts to about 8° C. for the addition of 1 per cent. of tungsten. This element behaves like other alloying elements in increasing the efficiency on hardening at the slower rates of cooling such as are involved in the heat treatment of large masses. Its effect in this direction is most pronounced when added to nickel steels containing about 6 per cent. of nickel. Addition of tungsten also reduces the fall of hardening produced by tempering. The carbon-tungsten steels containing up to 1.7 per cent. of tungsten, and the 3.5 per cent. nickel-tungsten steels containing less than 1.5 per cent. of tungsten, with a carbon content of 0.3 per cent., did not give sufficiently good mechanical properties to be considered as high tensile constructional steels. Remarkably good properties are, however, given by the 6 per cent. nickel steel containing 0.3 per cent. of carbon and 0.6 per cent. of tungsten. The steel giving the most promise of useful application was a steel with 6 per cent. of nickel and from 0.6 to 1.0 per cent. of tungsten. The author's final conclusion is that while tungsten, in common with other alloying elements, beneficially affects the properties of constructional steels, there is nothing so distinctive in its influence as to warrant any special recommendations in its favour.

The Evolution and Colonisation of Tidal Lands.

THE joint discussion on "The Evolution and Colonisation of Tidal Lands" between the Sections of Botany and Geography during the British Association meeting at Southampton was opened by Prof. F. W. Oliver, who spoke of the raw materials that go to the making of tidal lands, namely, shingle, sand, and fine silt, and of the transport of these by tide, currents, and wind. Plants can only become established on tidal lands during periods of quiescence. Vegetation thereon arises almost entirely from sea-borne seeds, the sea also bringing drift which in time enriches the ground with humus. Plants as they become established collect and hold silt and blown sand, and are, therefore, in effect creative. In the case of sand dunes, the conditions were traced which lead to permanence. The parts played by *Agropyrum junceum* and *Psamma arenaria* in the building of dunes were discussed, it being pointed out that the latter was liable to be killed when invaded by abnormally high tides for some hours. Gales of 60-70 miles an hour stimulated the formation of dunes owing to the consolidation of the sand by wind force. Salt marshes differ markedly in type according to the nature of the ground, being either sandy or slushy or consisting of firm mud. Their proper development requires the concurrence of a number of plants at each successive phase. Reference was made to the almost unique capacity of *Spartina Townsendii* to occupy the softest muds and to spread rapidly on them. Its efficiency in such ground is comparable to that of marram grass in sand and *Suaeda fruticosa* in shingle.

The possibilities of artificial control of the shore line by appropriate planting and conservation of plants were alluded to, and the possibility of consequent injury to navigation pointed out. Extensive mud flats are the natural "hinterland" of a system of tidal creeks or channels, and if the level of these muds be unduly raised by the silting action of halophytes, by so much is the volume of tidal water that can enter a harbour reduced. In the absence of sufficient water to scour out the channels at later stages in the ebb, they are always liable to become shallow and ultimately choked.

Prof. J. W. Gregory laid stress on the fact that although deposition by rivers and currents in the formation of tidal lands was of vast importance, coast erosion was also accompanied largely by the deposition of the matter thus set free. This deposition took place rapidly in sheltered positions. Sedimentation was much more rapid and complete in salt water than in fresh. Thus the transport of the products of erosion was restricted, and sedimentation in protected places along the coast was easy. Three processes are involved in the deposition of such tidal lands; first, the formation of a sand bar; second, the formation of a spit of longshore drift; and third, the deposition of plains in quieter waters behind the bar or spit. The development of these features on the British coasts was illustrated by reference to the records, from Roman times onwards, of the

mouth of the Humber and other rivers. Mention was also made of the occurrence of similar phenomena on the coasts of Australia and Burma. In conclusion it was pointed out that the conditions controlling tidal-land formation at the present time were probably similar to those under which the great coal fields of the world had originated.

Prof. R. H. Yapp dealt particularly with the colonisation of the mud flats in the Dovey estuary in Wales. The vegetation succession *Salicornia* → *Glyceria* → *Armeria* → *Festuca* was described. In the early stages vertical accretion of silt is rapid, but the rate decreases as age advances. Stress was laid on the efficiency of the dominant plants as silt-binders. Sun-cracks, even during prolonged drought, rarely appear on such surfaces covered with vegetation, except in the earlier phases of colonisation when roots are few and binding less complete. Erosion resulting in the undercutting of the margins of the marsh and of the numerous drainage "pans" was described step by step. The rate of retrogression due to such erosion is slow compared with the rate of the various constructive forces leading to the increase of tidal lands.

Dr. Vaughan Cornish pointed out that little attention had been given to the importance of the ebb and flow tides in the formation of tidal lands. This was mainly due to the difficulty of observation. He described the interplay of ebb and flow tides in the passage of detritus, and held that the beach is stroked intermittently in one direction only, that of the flood tide. In this connexion it is important for local authorities and coastal engineers to examine carefully the movements of detritus at the turn of the tides.

Lord Montagu of Beaulieu spoke of his contact with the work of Prof. Oliver, and of his firm belief that only by the co-operation of local authorities with trained botanists could the problems of coast protection be dealt with adequately. His own experiments on reclamation were referred to with the object of dispelling the belief that easy and quick returns from grass crops could be secured by enclosing and draining salt marshes. He stated that *Spartina* sometimes acted indirectly as a denuding force, owing to the current being concentrated into narrower channels through the growth of the grass. This led to the falling in of the banks in consequence of undermining.

Dr. E. J. Salisbury described chiefly the ecological changes occurring in sand dunes with increasing age. There is a gradual diminution of calcium carbonate as the dune gets older, owing to the accumulation of carbon dioxide through the action of micro-organisms leading to a rise in the hydrogen-ion concentration. This is correlated with changes in the types of plants found on the dunes at different ages. Whereas the pioneer plants of the dunes are "lime-loving," several chalk down plants being commonly found, the character of the vegetation gradually changes until the old dunes are covered with plants characteristic of acid soils, such as heather.

Natural Mental Tests.

NATURAL mental tests are defined, in a pamphlet recently received, by Mr. Arthur MacDonal, of Washington, as "studies of man which have for their object an estimate of him with reference to his reputation, education, and culture, and also with regard to the things he has done, the results he has accomplished . . . in short, his mental products."

Thus a study of the occurrence in a group or community of men of genius or talent, those who are noted for literary, scientific, or any other educational achievement, forms a test of the mentality of that group. Such a series of natural tests is of considerable anthropological significance. By means of them we compare the effects of various conditions and

environments upon the mental status of the average man, who is the representative of the community. Mr. MacDonald has brought together the data from a number of studies of man's mentality which, though not designed for that purpose, form such a series.

Mental ability has been found to resemble the physical properties of man in range and distribution; it conforms to the normal curve of distribution. Thus among a representative group, the proportion of successful men is about the same as that of morons and individuals of low-grade intelligence; and the proportion of men of great talent and genius the same as that of idiots and imbeciles. The range of intelligence above the normal ordinary man is as great as the range below.

In general, men of outstanding ability obtain a great reputation among their contemporaries; so that we are enabled to compare the varying occurrences of men of genius and of talent by means of their reputations. The number of such occurrences varies chronologically, with nationality and geographical situation, with social origin and parentage, and with degree of education. Finally, there are various types of genius and talent which occur in fairly constant proportions among different communities.

Not much reliance can perhaps be placed upon data dealing with the number of eminent men who have lived in the various centuries and decades of our history; for the spread of publicity and the improved means of communication are likely to give an advantage to more recent periods of time. It is interesting to note, however, that while men of talent increase in number up to recent years in Great Britain and in the United States of America, the largest number in France lived in the seventeenth century.

When we turn to a comparison of the number of great men of science in various countries, however, we do not find any advantage resting with the English-

speaking races. Ever since 1750 Switzerland has had the largest number of associates of foreign Royal Societies; Holland has sunk from second place to tenth, Germany has risen from low down to third, and France is high throughout. England is about sixth, and the United States about tenth throughout. In Great Britain itself, the Nordic races have a great advantage as regards men of genius. England and Scotland much out-top Ireland and Wales—a fact which is fairly generally recognised.

Coming to the influence of social origin and environment, we find that it is the great middle class, the commercial and professional group, the "neither poor nor wealthy," which produces the bulk of talent and genius both literary and scientific. In France and in the United States also, it is the urban rather than the rural districts which have the advantage in this respect. This is probably connected with the superiority of educational opportunity in the former, for naturally we find more talent among educated than uneducated persons; 80 per cent. of a group of distinguished American men of letters had received at least a high-school education, while 98 per cent. of a group of talented French men of letters were well educated.

Dividing men of genius into men of letters, sciences, arts, and action, we find that in all countries the greatest number of men of genius are men of letters, especially in France and Germany. Men of action come next in all countries except Germany, where there are more men of arts and sciences with genius. In most countries the arts have the advantage of the sciences.

These conclusions probably need the support of more statistical evidence to become firmly established, and to show clearly their bearing upon one another. They nevertheless form the introduction to a number of interesting problems connected with variation of mentality in man.

M. D. VERNON.

Bergens Museum.

ON April 25 Bergens Museum celebrated its centenary by a festival to which representatives of Norwegian, Danish, Finnish, Icelandic, and Swedish institutions were invited, and by the publication of a handsome volume, which permits the friends of the museum in other countries to share the interest and to offer congratulations to their colleagues of Bergen. In 1900 a complete history down to that date was published by Dr. J. Brunchorst. The present work records the remarkable expansion during the succeeding quarter of a century, and the fruition of ideas that germinated in the bygone decades.

Bergens Museum has never been content to remain a mere storehouse and exhibition. It has been a centre of scientific research and of the publication of the results to all classes. The museum itself has so grown that it has occupied three successive buildings. To the last of these, two wings were added about 1900, and an entirely new building for the history of culture now approaches completion. The museum also has a separate laboratory and a modern biological station, and is about to erect a building for its geophysical institute. It possesses a seismological station, a bio-chemical laboratory, and a botanical laboratory.

The two serial publications of the museum—the yearbook for researches and *Naturen* for popularisation—are widely known. Among many separate publications, "An Account of the Crustacea of Norway" by Dr. G. O. Sars stands pre-eminent. To the printed word is added the spoken. Not only are there popular lectures, but there have also arisen regular schools in zoology, botany, and geology, with

the right of examining their students for public posts.

Thus we arrive at the goal of the museum's activities, its incorporation—which cannot much longer be delayed—as the University of Bergen. Already its staff of 25 men of science includes 8 recognised professors. The ideas that had been gaining ground since 1892 were set on a broader basis in 1915. Plans were prepared and funds solicited. The intention was first to establish faculties of natural science and of medicine based on the museum and such medical institutions as exist in Bergen. Unfortunately the hard times have rendered it impossible to have these two faculties at work in the centenary year; but the course of future development is marked out and will undoubtedly be followed so soon as the economic situation permits. Many a university has founded a museum of high rank; but we do not remember a museum that, beginning as a private institution in a single school-room, has so determinedly used its energies for the highest and widest ends of learning as to blossom into a university for which a prosperous future is assured.

In its earlier years men of the highest scientific distinction were connected with Bergens Museum, such as D. C. Danielssen, Herman Friele, Fridtjof Nansen, G. Gustafson, A. Appellof, and Jørgen Brunchorst. A welcome feature of the present volume are the portraits and brief biographies of those who have served the institution during the present century. Into the hands of the present staff the future of Bergens Museum and Bergens University may be entrusted with confidence.

F. A. B.

The Tensile Properties of Single Iron Crystals.

AT the autumn meeting of the Iron and Steel Institute held in Birmingham on September 9-11, Prof. C. A. Edwards and Mr. L. B. Pfeil presented a continuation of their work on the subject of the tensile properties of single iron crystals. Eighteen months ago, they succeeded in preparing some large iron crystals by the method of straining and heating introduced by Carpenter and Elam. The

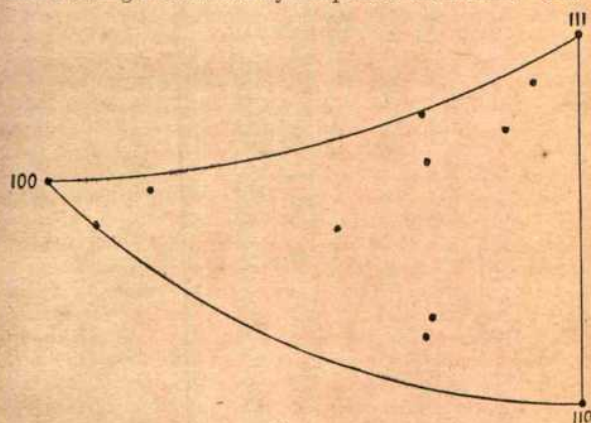


FIG. 1.

large crystals described in the present paper were prepared by this method, although some small modifications have been introduced which allow them to be made with greater certainty. This method consists, briefly, in so treating the original mild steel sheets as to obtain a grain size of 120 per square mm. Suitable strips were decarburised at 875°C . for 48 hours, heated to 1000°C . for 12 hours, and finally slowly cooled. In this way a number of strips $8\text{ in.} \times 1\frac{1}{2}\text{ in.} \times \frac{1}{8}\text{ in.}$ were obtained, each strip consisting of one large crystal in the central part. In all cases it was necessary to remove the surface film of fine crystals by carefully filing before the existence of the large crystals could be detected by light etching. Test-pieces were cut from these with the aid of a manganese templet. This ensured that they were all of the same size and minimised the risk of bending of the metal, which is very soft. The test-pieces were $2.5\text{ in.} \times 0.75\text{ in.} \times 0.110\text{ in.}$

The stress elongation curves obtained show that up to about two tons per square inch the strain was proportional to the stress, and further that there was no well-defined yield point. In this respect, therefore, single crystals of iron behaved quite differently from the ordinary microcrystalline metal, which has a well-defined yield point and approximated much more nearly to a non-ferrous metal such as copper. Later on in the paper the authors give a diagram showing the gradual development of a yield point in this iron as the size of the crystals is diminished and crystal boundaries come more and more into play. It may, therefore, be concluded that this very characteristic property of microcrystalline iron is due in some way to the influence of the crystal boundaries. The limits of proportionality of ten crystals were determined and were found to vary from 1.72 to 2.52 tons per square inch, with a mean figure of 2.19. It is possible, however, that these values are too high, since the filing of the specimens will in all probability have caused some work hardening of the metal. The limit of proportionality of microcrystalline iron is about eight tons per square inch, so that the values for single crystals are little more than a quarter of this and may possibly be even less.

Tensile strength determinations were carried out on 25 crystals. Eighteen of these give figures in the neighbourhood of 10 tons per square inch. The corresponding figure for microcrystalline iron is about 20 tons, so that the tenacity of the single crystal in more than two-thirds of the test-pieces is only about half that of the metal in the ordinary form. In the remaining 7 single crystal test-pieces, however, the values varied from 11 to, in one case, 15.38. In this case, therefore, the tenacity of the single crystal was fully three-quarters that of the microcrystalline metal. This figure, however, is well below the highest figure for single crystals of aluminium obtained by Carpenter and Elam, namely, 90 per cent. of the tenacity of the microcrystalline metal. It is interesting to notice that, on the whole, the single crystals possessing the highest tenacity were also the most ductile. Figures varying from 30 to 53 per cent. were obtained. Corresponding to these differences of tenacity and ductility, the crystals distorted in different ways during the tests. The majority of test-pieces broke similarly to type II. of the aluminium crystals described by Carpenter and Elam; that is, the crystals retained their width but diminished in thickness. At the fracture they drew down to a knife edge and parted in a straight line nearly at right angles to the axis of the test-piece. Crystals which gave a higher tenacity and ductility both narrowed and thinned and showed a marked tendency for the cross section to change from a rectangle to a parallelogram (Carpenter and Elam, type IV.). At the point of fracture they necked and broke without drawing to a knife edge. Just before parting a large slip occurred on a plane making an angle of 45° with the length of the strip and with a "dip" of 45° . The crystal which broke at 15.38 tons per square inch gave a fracture different from the two types mentioned. It narrowed, thinned, and also necked.

Prof. Edwards and Mr. Pfeil have not as yet been able to determine the orientation of these crystals.

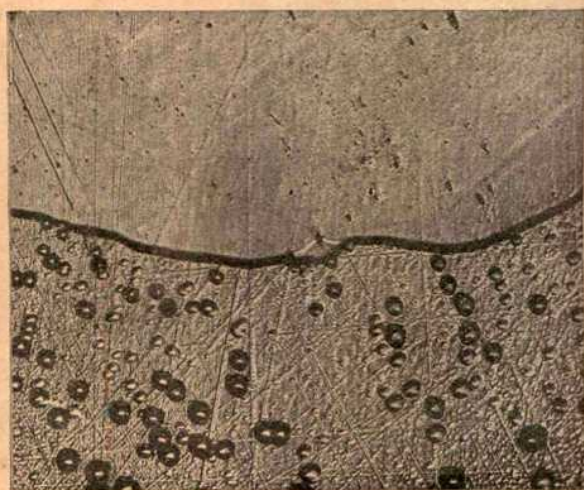


FIG. 2.

It is tolerably certain that the differences in tenacity, ductility, and method of distortion correspond to differences of original orientation of the crystals and of the method of distortion. The authors state definitely that the orientations of twelve crystals examined by them were not identical, basing this opinion on an examination under oblique illumination, and they speculate as to how it is that equal tensile strength values can be associated with variations in

orientation. It is important to point out, however, that they do not yet know whether an iron crystal during a tension test slips upon a dodecahedral plane or cube plane, or indeed upon either of these. This work has still to be done.

A beginning, however, has been made by Miss Elam, who contributed a note at the same meeting entitled "The Orientation of Crystals Produced by Heating Strained Iron." In their previous paper, Prof. Edwards and Mr. Pfeil had stated that square etching pits were frequently obtained with a diagonal in the direction of straining, and concluded from this and other observations that the crystals were similarly oriented. Miss Elam has examined several of their single crystals by X-ray methods, and the crystal axes relative to the axis of the strip of ten crystals have been determined. Some of them have been done by her and the remainder by Mr. R. W. Aston at the Cavendish Laboratory, Cambridge. The accompanying diagram (Fig. 1) represents part of the stereographic projection of the crystal axes with the positions of all the axes of the test-pieces, and hence the direction of straining, marked by a point. The relation of each point to the three principal crystal axes, *i.e.* the apices of the spherical triangle marked (100), (110), and (111), indicates the orientation of the crystal. This diagram shows that the points are scattered throughout the triangle and that the orientation of the crystals is consequently very varied.

Only two crystals showed cubic etching pits, and in both of these the surface of the strip was parallel to a cubic (100) plane in the crystal. These pits were quickly developed by etching in dilute nitric acid, whereas the other crystals appeared unattacked. When first formed the pits were rather indefinite-shaped pyramids, but on prolonged etching they became square. Crystals of other orientations showed pitting only on prolonged etching, and although the form varied from crystal to crystal, the pits had no regular shapes. Fig. 2 shows two crystals. The lower one is deeply pitted and has a cube face nearly in the plane of section. The upper one is not pitted and is attacked to a less extent although more uniformly. X-ray examination showed that the plane of the section was approximately a (112) plane. Miss Elam's experiments show, therefore, that the single crystals produced by Messrs. Edwards and Pfeil have not necessarily the same orientation, and that it should be possible to pick out those in which a (100) plane lies in or near the plane of section.

H. C. H. C.

University and Educational Intelligence.

ABERDEEN.—Kilgour research scholarships have been awarded to Miss E. H. M. Geddes (botany), and to Miss I. Dean and Mr. A. H. H. Fraser (zoology).

The University Court has appointed the following assistants: botany, Mr. N. J. G. Smith and Dr. R. Crookall; materia medica, Mr. T. J. C. Macdonald; pathology, Mr. J. Gray; zoology, Nita I. Rennet.

BIRMINGHAM.—At a meeting of the Council of the University on October 7, the following appointments were made: Dr. W. C. Osman Hill to be demonstrator of anatomy; Miss H. I. Pfister to be lecturer in physiology; and Mr. J. F. D. Shrewsbury to be lecturer in bacteriology.

The foundations of the new buildings for the biological departments having been completed, work

has been begun on the superstructure. The new building for the oil-mining departments is nearing completion.

CAMBRIDGE.—Dr. A. C. Seward, master of Downing College and professor of botany, has entered on his second year of office as vice-chancellor.

The Cambridge University Commissioners are considering their draft of the new statutes; it is expected that it will be published before the term divides and that the final document will go to the Privy Council before the end of 1925; its provisions will not come into operation until the beginning of the academic year 1926-27.

For the moment local interest is focussed on the new restrictions of the motoring activities of persons *in statu pupillari*. Mr. D. Portway, of St. Catherine's College, has been nominated as special pro-rector to deal with the enforcement of the new regulations. There are some members of the Senate who view any new restrictions as contrary to the "Spirit of Progress," but the discussions and voting last term showed quite clearly that a large majority felt that restriction of some kind was imperative and would be wholesome.

H.I.H. the Prince Regent of Japan, who visited the University and took an honorary degree in 1921, has presented the library with four cabinets containing the 666 volumes of the Gunsho Ruiju and a framed portrait of their blind author.

It is announced that there will be an election to an Isaac Newton Studentship (for research in astronomy or physical optics) early in the present term.

THE third annual report of the Imperial College of Tropical Agriculture, for the year ended December 31, 1924, has just been issued, and is a very satisfactory and interesting document. At the close of the year there were eighteen diploma students and fourteen post-graduates working at the College. As there were only six post-graduates on the register at the beginning of the year, the increase of this type of student is very satisfactory. The College is still hampered by lack of adequate funds for the completion and equipment of its new buildings and laboratories, and for the building of a hostel, which is so desirable an addition to the College for the proper accommodation of the students. As a result of the appeal for 100,000*l.* made by the late Lord Milner, 21,083*l.* were contributed during the past year, and this sum has been slightly augmented since the report was published. The report records the laying of the foundation stone of the new building of the College on January 14, 1924, at which several members of the Governing Body were present, including Sir Arthur Shipley, the chairman. Reference is also made to the death of Mr. Claude Tinné Berthon, honorary consulting engineer to the College, who not only designed and superintended the erection of the Instructional Sugar Factory, but was also largely responsible for securing gifts of machinery and plant from the British Sugar Machinery Manufacturers and allied firms to the value of upwards of 20,000*l.* towards its equipment. The year under review was also marked by the retirement of Sir Francis Watts, the first principal of the College, who had been Imperial Commissioner of Agriculture for the West Indies for twenty-four years. Sir Francis, in recognition of his services, was appointed, on his retirement, to the honorary position of Principal Emeritus of the College. The report also records the appointment of Dr. Hugh Martin Leake, formerly principal of the Agricultural College, Cawnpore, to be principal of the College in succession to Sir Francis Watts.

Societies and Academies.

CAMBRIDGE.

Philosophical Society, July 20.—Sir J. J. Thomson: The structure of light.—A. S. Eddington: Internal constitution of the stars.—H. Nagaoka: The transmutation of mercury into gold.—W. Burnside: On groups of linear substitutions which contain irreducible meta-cyclical subgroups.—S. Pollard: On Hausdorff's proof of the extended Riesz-Fischer theorem.—M. H. A. Newman: On the theorem of Pappus.—C. G. Darwin: Notes on optical constants.—R. de L. Kronig: The theory of the influence of magnetic fields on the stopping power of gases for α -particles.—J. T. Saunders: The trichocysts of paramacrum.—V. Nath: Spermatogenesis of *Lithobius forficatus*.—H. Munro Fox: The effect of light on the vertical movement of aquatic organisms.—E. C. Francis: (1) On differentiation with respect to a function. (2) The Lebesgue-Stieltjes integral.—D. H. Black: The β -ray spectrum of the natural L -radiation from radium B.

PARIS.

Academy of Sciences, August 24.—C. Sauvageau: The presence of free iodine in *Polysiphonia Doubletii*. A definite proof is given that iodine in the free state is present in this plant.—L. Escande: Similitude extended to high velocities. Supplementary researches on the similitude of viscous fluids.—R. de Malleman: The calculation of the rotatory power of a tetrahedral molecule. It is concluded that the existence of rotatory power, in an asymmetric molecule, is not incompatible with optical isotropy of the atoms.—Agafonoff and Mlle. Malicet: Some considerations on the lower loess of the neighbourhood of Paris.—J. Cabannes and J. Dufay: Measurement of the height of the ozone layer in the atmosphere. The assumption is made that the ozone layer is so high that the sunlight is first filtered by the ozone and then diffused by the lower layers of the atmosphere. The heights deduced are about 50 kilometres.—Bordas, François-Dainville, and Roussel: The elimination of benzoic acid and the benzoates in the body economy. In six out of seven cases, the complete elimination of benzoic acid took three days, and it is concluded that the continuous administration of benzoates, as when used as a food preservative, might, owing to accumulation in the body, give rise to serious troubles.—Paillot: The *grasserie* of the silkworm. This disease causes the most serious losses in the silkworm industry, and has been more prevalent in 1925 than in the preceding years. There is no certain cure for the disease, but some precautions are detailed which reduce the chances of infection.

August 31.—André Blondel: A modification of Lord Rayleigh's photometric method, rendering possible the use of a diffusing comparison surface in photometry.—Michel Akimoff: Confluent hypergeometric functions.—Nicola Obrechhoff: The summation of Fourier's series of analytical functions.—Kolossof: General solutions.—Carl A. Garabedian: Solution of the problem of the thick rectangular plate having two opposite sides supported and two sides free, and carrying a load uniformly distributed or concentrated at its centre.—Hoegelen: Circular arcs of uniform thickness. Application to arched barrages.—D. Foucher and E. Rougetet: Contribution to the study of the mistral. The acceleration. An experimental study in the Rhone Valley shows that the velocity of the wind is the resultant of two velocities, one determined by the barometric gradient, the other caused by local conditions (orographic velocity).—Jules Amar: The mode of walking known as "*sur la pointe des pieds*." The mode of walking

described by the author (with MM. d'Arsonval and Gautiez) has been misunderstood: details of the correct method are given.—Fernand Wyss: The biochemical estimation of insulin. A method of testing the strength of insulin *in vitro* is given, based on the retardation of the oxidation of resorcinol by hydrogen peroxide in the presence of insulin.

CAPE TOWN.

Royal Society of South Africa, August 19.—S. H. Haughton: On some new mollusca from tertiary beds in the west of the Cape Province. The following new mollusca are described from a deposit at Doornbaai on the Van Rhyndorp coast, south of the Olifants River mouth: *Mytilus tomlini*, sp. nov. *Donax (Iphigenia) rogersi* sp. nov. and *Chamelea Krigeri* sp. nov. The beds from which the shells were obtained average about 10 feet in thickness and form the upper portion of marine cliffs, which attain a height of 50 to 60 feet above sea-level.—R. S. Adamson: On the anatomy of some shrubby Iridaceæ. In the S.W. Cape region there are five species of the Iridaceæ which form woody stems with secondary growth. The main features of the structure of these plants were described. While the general type of secondary growth is the same as that occurring in other Monocotyledons with secondary thickening, there are many differences in detail. The secondary tissues are much more compact and in some of the plants show a definite arrangement into concentric growth zones.—V. A. Wager: The breeding habits and life-histories of some of the Transvaal Amphibia. In this paper the author describes the life-histories and habits of two species of Transvaal batrachia, *Chiromantis xerampelina* and *Rappia marmorata*; both are tree-living, the terminal phalanges being provided with adhesive discs. In the first-named species the eggs are laid in the form of a large white glutinous mass on branches overhanging water. The tadpoles drop from the egg-mass into the water where they complete their metamorphosis. The fore-limbs, before breaking through the operculum, are already provided with phalangeal discs. The tadpole does not increase in size during metamorphosis, and when the tail disappears the young frog leaves the water for an arboreal existence. In *Rappia marmorata* the eggs are laid in a jelly-like mass under water. A peculiarity of the tadpole is the absence of horny jaws, comb-teeth, or papillæ of the mouth, which bears a superficial resemblance to that of the tadpole of *Xenopus laevis*, but from which it can be readily distinguished by the absence of the two tentacles at the sides of the mouth. From this it is concluded that the tadpole feeds on micro-organisms in water drawn through the unusually large spiracle, and this is borne out by an examination of the intestinal contents, which includes amongst other organisms Euglena, Volvox, and a few minute annulates.—B. F. J. Schonland: Cathode ray scattering. Preliminary measurements of the scattering of fast cathode rays through 90° have been made under conditions which ensure "single" scattering. Values for the nuclear charges of gold and aluminium are derived from these results which lie within 12 per cent. (the experimental error) of the true values. They support the addition of the relativity correction to the orbit of a β -particle, this correction having the high value of 2.40 in the present case.—C. W. Kops: Marriage and mortality rates of the population of the Union of South Africa according to the conjugal condition of the population. The paper is a preliminary investigation into the marriage rates among widowed persons and never-married persons, and the death rates among widowed, never-married, and married persons.

Official Publications Received.

- Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 24, Part 6. A Bibliographic Study of Beauvois' Agrostographie. By Cornelia D. Niles. With Introduction and Botanical Notes, by Agnes Chase. Pp. xix+135-214 (Washington: Government Printing Office.) 15 cents.
- Department of Commerce. Bureau of Standards. Circular of the Bureau of Standards, No. 276: Motor-Vehicle Headlighting. Pp. 28. (Washington: Government Printing Office.) 20 cents.
- Institut de France. Académie des Sciences. Annuaire pour 1925. Pp. 379. (Paris: Gauthier-Villars et Cie.)
- Sitzungsberichte der Physikalisch-medizinischen Societat in Erlangen. Herausgegeben im Auftrag der Societat von Oskar Schulz. 54. und 55. Band, 1922, 1923. Pp. xxiii+429+8 Tafeln. (Erlangen.)
- Fifty Years of Local Science, 1875-1925: a Record of Fifty Years Work done by the Members of the Bradford Natural History and Microscopical Society and the Bradford Scientific Association. Edited by H. J. M. Maltby and W. P. Winter. Pp. 34+2 plates. (Bradford.) 6d.
- County Council of the West Riding of Yorkshire: Education Committee Report on the Examination for County Minor Scholarships, 1925. Pp. 33 (Wakefield: Education Department, County Hall.)
- The Edinburgh and East of Scotland College of Agriculture. Calendar for 1925-1926. Pp. 94. (Edinburgh.)
- Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 3, No. 25: Some Points in the Anatomy of Dickinsonia. By Samuel Williams. Pp. 286-296+2 plates. 1s. 6d. Vol. 45, Part 3, No. 26: On the Vertical Force Changes during the "Sudden Commencement" of a Magnetic Storm. By Dr. A. Crichton Mitchell. Pp. 297-301+1 plate. 9d. Vol. 45, Part 3, No. 27: A Colour Vision Spectrometer. By Prof. W. Peddie. Pp. 302-307. 6d. Vol. 45, Part 3, No. 28: A Ball-and-Tube Flowmeter. By Sir J. Alfred Ewing. Pp. 308-321+8 plates. 2s.
- (Edinburgh: R. Grant and Son, London: Williams and Norgate, Ltd.)
- New Zealand Nineteenth Annual Report (New Series) of the Mines Department, Geological Survey Branch. Pp. 13. (Wellington, N.Z.: W. A. G. Skinner.) 6d.
- Prospectus of the Royal College of Art, S. Kensington, London Session 1925-1926. Pp. iv+28 (London: H.M. Stationery Office.) 6d. net.
- Comptes rendus des séances de la Conférence géodésique réunie à Helsingfors du 28 juin au 2 juillet 1924. (Verhandlungen der in Helsingfors vom 28 juni bis 2 juli 1924 abgehaltenen Geodätischen Konferenz.) Rédigés par le Secrétaire-général, Ilmari Bonsdorff. Pp. iv+150. (Helsinki: Valtioneuvoston Kirjapaino.)
- Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1922-23 Vol. 2. Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, and Land Revenue Assessment, in certain Indian States. Pp. vii+85 (Calcutta: Government of India Central Publication Branch.) 12 annas; 1s. 3d.
- The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 8, No. 2: On some Paleozoic Molluscs of Japan. 1: Lamellibranchiata and Scaphopoda. By Ichirô Hayasaka. Pp. 54+2 plates (Tokyo and Sendai: Maruzen Co., Ltd.)
- The Memoirs of the Imperial Marine Observatory, Kobe, Japan Vol. 2, No. 1. Pp. 81+20 plates (Kobe.)
- Contributions to Palaeontology from the Carnegie Institution of Washington. Studies on the Fossil Flora and Fauna of the Western United States. (Publication No. 349.) Pp. iii+130+25 plates. (Washington: Carnegie Institution.)

Diary of Societies.

SATURDAY, OCTOBER 17.

- MINING INSTITUTE OF SCOTLAND (at Royal Technical College, Glasgow), at 5.—Discussion on paper by E. H. Frazer on Safety First in Mines.—Prof. R. W. Dron: Notes on Cleft in the Scottish Coalfield.
- PHYSIOLOGICAL SOCIETY (at Guy's Hospital)

MONDAY, OCTOBER 19.

- SOCIETY OF SUPERINTENDENTS OF TUBERCULOSIS INSTITUTIONS (at 122 Harley Street, W.), at 3.—Dr. J. W. Linnell: Some Reflections on the Diagnosis and Treatment of Tuberculosis.—Dr. F. R. Walters: Needs and Indications in Pulmonary Tuberculosis.
- ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 4.—Sir Frederick Mott: The Progressive Developments of Harvey's Doctrine of *Omne vivum ex ovo* (Harveian Oration).
- ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Mr. Shattock: Demonstration of Specimens illustrating Lips and Tongue.
- JUNIOR INSTITUTION OF ENGINEERS (North-Western Branch) (at 16 St. Mary's Parsonage, Manchester), at 7.30.—A. N. Haworth: Engineering Troubles.
- NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Middlesbrough), at 7.30.—T. B. Lewis: Chairman's Address.
- HUNTERIAN SOCIETY (at Simpson's Restaurant, Cheapside), at 7.30.—Dr. F. H. Humphris: Light (Presidential Address)
- CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court, S.W.), at 8.—Annual General Meeting.

TUESDAY, OCTOBER 20.

- ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the months of June, July, August, and September.—L. C. Bushby: Exhibition of Insects recently exhibited in the Insect House.—Capt. E. W. Shann: Exhibition of Cinematograph Films taken on board the *Salpa* at Plymouth.—Dr. G. K. Noble: Voice as a Factor in the Breeding of Batrachians.—Dr. J. Stephenson: The Oligochaeta of Spitzbergen and Bear Island; some Additions and a Summary.—R. I. Pocock: The External Characters of the Catarrhine Apes and Monkeys.—G. C. Robson: The Deep-Sea Octopoda.

- INSTITUTE OF MARINE ENGINEERS, at 6.30.—Presidential Address.
- ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt. J. G. Noel: The Mount Everest Expedition (Lecture)
- INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Discussion on paper by A. J. T. Taylor entitled The Ruths Steam Accumulator.—D. MacNicol: The Jubilee of the Marine Spring-loaded Safety Valve.
- ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Miss Winifred S. Blackman: The Customs of the Modern Peasant Population of Egypt.
- SOCIOLOGICAL SOCIETY (at Royal Society), at 8.15.—The Coal Crisis as illustrating the Modern Transition.—Prof. Geddes: Changes in the Coal Industry as Symptoms of Social Transition.—J. A. Hobson: The Required Economic Adjustments.—Dr. Saleeby: The Required Hygienic Adjustments.—Prof. Abercrombie: The Regional Planning of New Coalfields.—Prof. Desch: The Required Technological Adjustments.—E. Kilburn Scott: The Adaptation of the Coal Gas Industry.

WEDNESDAY, OCTOBER 21.

- SOCIETY OF GLASS TECHNOLOGY (at the University, Sheffield), at 2.30.—T. C. Moorshead: The Glass Industry and Future Developments (Presidential Address)
- ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. J. D. Rolleston: Voltaire and Medicine Part I.
- NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at Chamber of Commerce, New Street, Birmingham), at 5.30.—J. W. Hall: A Preiss, with Annotations, of a Diary of a Tour in the Midlands in 1823, kept by Joshua Field.
- INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates Meeting) (at Chamber of Commerce, Birmingham), at 7.30.—T. Grover: The Influence on Engine Performance of Cylinder Arrangement and Construction.
- ENTOMOLOGICAL SOCIETY OF LONDON, at 8.
- ROYAL MICROSCOPICAL SOCIETY, at 8.—Prof. A. G. Hornby: Otoliths of Large Eels from the Albufera of Valencia.—Dr. Helen Ingley: Note on the Termination of the Podic (Perivascular Foot) of Fibrous Neuroglia Cells.
- INSTITUTE OF CHEMISTRY (London Section).

THURSDAY, OCTOBER 22.

- INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—R. A. Chattock: (Presidential Address).
- INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates Meeting) (at Luton), at 7.30.—A. J. Hancock: Address.
- INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham and Coventry Centres) (at Queen's Hotel, Birmingham), at 8.—H. K. Thomas: Presidential Address.

FRIDAY, OCTOBER 23.

- PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—H. E. Smith: The Influence of Strain on the Thomson Effect.—W. Mandell: The Measurement of Temperature by Thermocouples in Unequally Heated Enclosures.—W. Clarkson: On the Flashing of certain Types of Argon-Nitrogen Discharge Tubes.
- ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Preparations and Models to illustrate the Mechanism of the Internal Ear.
- ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. E. Saunders: Old and New Friends in the Zoo (Lecture).
- JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. S. Bower: The Construction and Laying of Reinforced Concrete Pipes.
- ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. T. S. Wilson: On the Management of Scarlatinal Epidemics in Boarding Schools.

SATURDAY, OCTOBER 24.

- INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District) (at Bridgwater), at 11.
- NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.
- BRITISH PSYCHOLOGICAL SOCIETY (at King's College), at 3.15.—B. Stevanovic: Conational Phenomena in Processes of Judgment.—Miss Ethel Stoneman: Apparatus used to investigate Electrical Changes accompanying Emotional States in the Insane. The Waller Emotometer and the Godefroy Tachogram.

PUBLIC LECTURES.

SATURDAY, OCTOBER 17.

- HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: The Story of Warfare in Europe

MONDAY, OCTOBER 19.

- UNIVERSITY OF LEEDS at 5.15.—Prof. E. G. Coker: Photo-Elasticity.
- KING'S COLLEGE, at 5.30.—R. J. Bartlett: Psychology and Education.

WEDNESDAY, OCTOBER 21.

- UNIVERSITY COLLEGE, at 8.—Prof. E. G. Gardner: Barlow Lectures on Dante: The Purgatorio. (Succeeding Lectures on October 28, November 4, 11, 18, and 25.)
- LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. C. S. Myers: Hindrances to Output.

THURSDAY, OCTOBER 22.

- KING'S COLLEGE, at 5.30.—Dr. B. Malinowski: The Contributions of Anthropology to Social Hygiene.

SATURDAY, OCTOBER 24.

- HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Defences of Animals.



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The Aeronautical Research Committee.¹

THE report of the Aeronautical Research Committee marks another milestone in the organisation of research in one of the comparatively newer fields. A study of this report, and the list of publications during the year, emphasises the progress that can be achieved by steady systematic team work.

Since the early days of aviation when the first bold pioneer steps were taken, there is scarcely a single outstanding achievement to the credit of any individual worker comparable with those that have occurred in other fields of scientific inquiry, and yet the progress that has been made is little short of wonderful. The modern aeroplane has acquired characteristics of speed and agility, stability and control, load-carrying capacity and strength of structure, a beauty of outline and a cleanness of design, that marks it out almost as belonging to a different species from its prehistoric ancestor of only twenty years ago. It is no criticism of the band of aeronautical enthusiasts to say that much of this result has been achieved in the main by the direct adaptation of well-recognised scientific knowledge and methods to a definite concrete end. An examination of the work of the Aeronautical Research Committee shows, in fact, that the main impetus has been received not so much from any specific first-class discovery of a purely aeronautical nature, but from the large number of points of contact the subject possesses with other branches of science.

Broadly speaking, the matter dealt with by the Committee on the technical side groups itself under the triple interlocking headings of 'aerodynamics, power, and materials, each of which embodies a network of specialised inquiry. Decentralisation is effected by six sub-committees, namely, aerodynamics, engine, materials and chemistry, accidents investigation, air transport, and structures. The separate branches of the work in each sub-committee are then dealt with in an appropriate panel of that sub-committee. The aerodynamics sub-committee, for example, has separate panels dealing with design, stability and control, airscrews, and sea-planes, while the materials and chemistry sub-committee branches out into panels on elasticity and fatigue, light alloys, fabrics and dopes.

A glance at this scheme of subdivision indicates the extensive range of subjects that bear directly on the specifically aeronautical field, and contribute towards its development. It is evident that the design and organisation of this scheme has been achieved only as a result of careful thought and mature experience. In itself it is an experiment in the organisation of research that is well worth study, while its success is borne out

¹ Report of the Aeronautical Research Committee for the Year 1924-1925. Pp. 44. (London: H.M. Stationery Office, 1925.) 1s. 6d. net

by the imposing list of concrete advances that are recorded in each annual report.

Among the numerous important papers that have been published by the Committee during the present year, an interesting feature is the rapid progress that is at last being made in the prediction of aerofoil performance. Until the development of the Prandtl vortex-theory, an impasse on the theoretical side of this subject had for all practical purposes been reached, and progress in aerofoil design was only to be sought by steady systematic, if arduous, wind channel tests. The development of the Prandtl vortex theory, unsatisfactory as it is in certain respects from an abstract theoretical point of view, has opened the way to classification of aerofoils and allied parts and prediction of performance to a remarkable degree of accuracy. The most recent investigations seem to suggest that even the aerodynamically complicated airscrew will yield up its properties to this remarkable theory.

One of the more important aeronautical problems of recent years is that associated with controllability, especially at low speeds or during stalling. As a result of investigations by the stability and control panel, the characteristics required in an aeroplane to make it controllable when stalled are now understood, and it has been demonstrated that these characteristics can be introduced by means of practical modifications in the organs of control. It appears that conventional aeroplanes are defective in two respects: they have insufficient rudder power, and the ailerons, when applied, effect a turning of the aeroplane and in so doing neutralise their direct effect on roll. It has been found by analysis, and verified by experiment, that either an increase of rudder power or the use of an aileron which does not turn the aeroplane would provide the pilot with sufficient power to regain an even keel from any position and so obviate the fatal spinning dive. The most successful device so far developed seems to be a combination of a Handley Page slot on the leading edge in conjunction with a balanced aileron of the Bristol-Frise type. This advance towards the elimination of one of the most potent causes of accidents is extremely encouraging.

In the actual constitution of the Aeronautical Research Committee, a change has this year been introduced which is likely to have a profound effect on the nature of the researches which are inaugurated. Future membership of the Committee is to be confined solely to members appointed in virtue of their scientific standing rather than as representatives of definite interests, such as, for example, the Society of British Aircraft Constructors. This change goes hand in hand with a modification in the nature of the duties of the Committee, which in future is to advise the Secretary

of State for Air on scientific matters relating to aeronautics rather than on scientific and technical problems relating merely to the construction and navigation of aircraft. In view of the fact that one of the functions of the Committee is to supervise the aeronautical research at the National Physical Laboratory, it will be obvious how far-reaching this change may be in determining the nature and trend of that research.

The work of the Committee is not confined to that conducted at the recognised research stations. Grants amounting to 1500*l.* have been made to enable individual workers to pursue a number of special investigations—experimental research on redundant structures, wind tunnel and theoretical research on skin friction and on the problem of control at low speeds. A sum of 1000*l.* will be available for a similar purpose during 1925–26. From the point of view of widening the field of interested researchers in aeronautical science, no better method could be adopted. It would be interesting to know, however, what machinery there is, if any, for ensuring that such detached workers maintain sufficiently effective contact with the main body of work in progress in aeronautical inquiries adjacent to their own, as the interval between completion of an investigation and publication by H.M. Stationery Office of the numerous R. and M. Reports is often considerable.

Without the financial backing of the Air Ministry, it is evident that the greater part of this extremely valuable scientific work would never have been undertaken at this stage. In the days of its inception, the activities of the Aeronautical Research Committee were naturally dominated largely by military considerations. At the close of the War, when the need for an impetus to commercial aviation became apparent, the nature of these considerations underwent a gradual transformation. The latest orientation of the Committee, where it has practically thrown off the necessity for concentration on problems either of immediate military or of commercial utility, while still retaining intimate contact with both these spheres, is a great achievement for the scientific outlook. It was, moreover, inevitable.

Solar Sophistry.

Le Soleil: ses phénomènes les plus importants, leur littérature et leur explication. Par A. Brester, Jz. Préparé à la publication par les soins du Dr. T. van Lohuizen. Pp. iv+315. (La Haye: W. P. van Stockum et fils, 1924.) n.p.

DR. BRESTER died on June 25, 1919, and this great monograph with pages 9½ by 11¾ inches, is published after his death by his wife and daughter, and is edited by Dr. T. van Lohuizen. It would, therefore, be unseemly to criticise any defects in the

printing or accessories of the book. But since the author continually elaborated one fundamental theory, during the thirty years that he devoted to the making of the book, if this theory was wrong initially, he had time enough to go very far wrong indeed.

The theory is one that no solar observer could entertain for a moment, for it is this: that the sun is in a state of absolute calm; that there is a complete absence of all radial convective movements; that the different vapours in the photosphere and chromosphere are in a stratification that is invariable and undisturbed by currents; that the prominences are not eruptions—*ever*, they are entirely tranquil in spite of their seeming movements, whether these be outwards from the sun radially or in the line of sight; that the spots differ in no wise in temperature from the photosphere in which they appear. But it was Dr. Brester's pride that "this theory has been elaborated, not by some astronomer who has made observations all his life, but by an amateur theorist, who has never made any observations at all." For, he says, astronomers have chosen a method (by observation) for getting their knowledge of the constitution of the sun,

"which is still too imperfect to allow them to elaborate a solar theory. And, besides, since astronomers are eminently patient scholars, finding an entire satisfaction in the production of observations, letting themselves be delayed or even turned aside willingly by their noble ambition to discover new facts, they occupy themselves rather with the 'How' than with the 'Why' of the phenomena, and, in short, they work above all for posterity. But the amateur theorist is in more of a hurry. He has only a very mild interest in posterity . . . and not being in the conditions in which he can make observations, he can give all his time and energy to the more interesting task of interpreting other people's observations, and it is thus . . . that *this* theory has been able to be built up"

In this year, 1925, six years only after Dr. Brester completed the writing of this book, posterity, in the form of a solar observer, can judge of Dr. Brester's method of interpreting astronomical observation, and can come to a fair conclusion as to whether his "hurried Why" is legitimately based on the astronomers' "patient How." Such is the purpose of the following criticisms.

In the very beginning, in his introduction, the author falls foul of "Kirchhoff's law" and "Doppler's principle." He seems to think that physicists apply this principle blindly, and he complains that Kirchhoff's law has become "an excessively dangerous guide" since "it can only have reference to calorific rays," and "the luminosity of a gas does not necessarily depend upon temperature, but more often upon a *luminescence* which is independent of temperature and results directly from chemical or electrical phenomena

in the luminous gas," and yet "the great majority of astronomers have never taken this sufficiently seriously." So he both uses and abuses the Doppler principle when giving^a an account of how the solar rotation is evidenced in the region of the reversing layer by the displacement of lines at the east and west limbs. These displacements are small and often very discordant, so he mentions four reasons that are usually accepted as explaining this, but urges most strongly a fifth of his own: "It seems due also to a *tenacious prejudice* that all the rays of the reversing layer ought to give the same rotation, and if they do not in fact do so, their mean will correspond to the real rotation."

Therefore, in accordance with this fifth reason, the author feels justified in dismissing observations of great weight, and accepting observations which the astronomers who made them deemed of little weight (as being few in number or made under bad conditions), because the former did not, and the latter did agree with what his theory set forth as to what the solar rotation should be. So he puts on one side the work done by Hastings, Young or Langley, and asserts that the measurement of spectral displacements only became of importance when Crew, in 1888, found from 10 chromospheric rays a slight polar acceleration instead of the polar retardation found by Carrington from sun-spots. But Brester complains that though Crew's measures were obviously insufficient and his conclusion carried no weight with solar astronomers, yet "this conclusion responded so well to my ideas, that I at once made it a principal foundation of my theory."

That is indeed the author's test of observation; on the plea of *tenacious prejudice* on the part of astronomers, a bad observation is admitted if it agrees with his ideas, a good observation incontinently rejected if it does not. In such a fashion he judges Dunér, Halm, and especially Adams. The latter's work published in 1907 Brester dismisses as of no account; that published in 1908, he declares, "gave a definitive solution to the problem," for the displacement of the H_α ray proved "that the rotation of the hydrogen atmosphere is precisely, as I had already described it in 1892, that is to say uniformly without polar retardation." In 1906-1907, also, Adams used 20 lines the displacement of which east and west were measured at 12 different latitudes, and, to Brester's indignation, he took the mean of these 20 lines in order to determine the variation of rotation with latitude, because their mean showed a polar retardation similar to that shown for the iron lines by Dunér. Still worse, Adams re-measured them in 1908, and in the case of the iron line 4291, which had previously given an *acceleration* of $0^{\circ} \cdot 54$ for latitudes 60° - 80° , he now found a *retardation* of $1^{\circ} \cdot 11$,

Yet, Dr. Brester says, Adams considers the 1908 observations as "probably better" than those of 1907. Indeed, the author shows so little appreciation of the conditions of measurement that he does not perceive that so close to the solar poles, the accidental errors are so large in measurement that any such differences are negligible.

Such criticism as Dr. Brester makes of Adams's spectroscopic work may perhaps be dismissed, as due to invincible obscurantism. Not so his habit of selecting only the observations which suit his theory, and ignoring in that connexion any that do not accord with it, even though these latter may be the special feature of the paper the authority of which he quotes. For example, in his section on the tranquillity of the reversing layer, he cites in proof of this a paper by Prof. Newall in the *Monthly Notices of the Royal Astronomical Society* for January 1907, that "*during the summer of 1906, which was a time of great solar activity, Newall and Hubrecht observed minutely the solar spectrum especially to try to discover any sign of movement; but they found not the smallest indication*" [the italics are Dr. Brester's]; "and it is therefore evident that the reversing layer, even during the period of spot maximum, is never traversed by such terrible radial currents as the partisans of the hypothesis of solar eruptions have always supposed." But the very point of this paper of Prof. Newall's was to emphasise that the year 1906 was abnormal in being quiet, since at the corresponding period of solar activity eleven years previously in 1895, the radial movements were very violent, as is usual at sunspot maximum.

Again and again, if we consult the authorities that Dr. Brester quotes, we find that he adopts this line of treatment: he suppresses all evidence that goes against his theory, and wrenches from its context anything that might, if isolated, appear to confirm it. One other example may suffice. On p. 143 he cites a note in the *Journal of the British Astronomical Association* for November 1916 by Prof. Eddington on "The Radiative Equilibrium of the Stars" to show "that it is wrong what every astronomer thought until quite recently, that convective currents are necessary to convey the heat from the centre to the surface." This is but a minor point in Prof. Eddington's work (though he does not affirm that convective currents play no part anywhere on the sun), but his main theme was that radiation-pressure plays a fundamental part in maintaining the radiative equilibrium of the sun and stars. Of this main theme, Dr. Brester makes no mention at all until p. 158, when he says we know of two forces which can have the effect of opposing gravity (where this is not great) at the sun's surface: (1) the pressure of radiation, and (2) the pressure of electrons continually projected from the whole solar

surface. It is the second, his *electro-luminescent* theory, to which he continually returns during the remainder of the volume, and by this he explains the prominences, quiescent or eruptive, and the corona. The first he ignores except by a single phrase, "an impossible effect of radiation-pressure," on p. 233.

Dr. Brester read much: his *Index Bibliographique* occupies nearly fifty pages; but the above are samples of how he treats his authorities. In his reasoning on evidence, he is not even consistent with himself. He defines a facula as a blister, and a spot as the bursting of this blister; to explain the east over west predominance of sunspots, he assumes that all faculae burst on their preceding side (p. 188); to explain the fact that magnetic storms occur as a rule after the spots with which they are connected have passed the central meridian, he assumes that all faculae burst on their following side (p. 210).

After all, astronomers are right in working for posterity, since it is by the verdict of posterity that any theory stands or falls.

Rapid Air Surveys.

Aerial Surveying by Rapid Methods. By Prof. Bennett Melvill Jones and Major J. C. Griffiths. Pp. xvi+159+26 plates. (Cambridge: At the University Press, 1925.) 16s. net.

IN the course of the operations during the War in Palestine, it was found that a very practicable method of making maps was to take a series of air-photographs in long, straight strips, forming a framework of triangles, or other figures; the detail inside these strips of photographs being filled in by photographs taken in parallel flights, so close together that the photographs overlapped. In this system, instead of having three or four points on each photograph, of which the relative positions were accurately fixed, it was possible to work from points fixed at very wide intervals; instead of having four fixed points a square mile, let us say, it was possible to construct a very fairly accurate map with three or four fixed points in a hundred square miles, or even less. It was on this system that the map of Palestine was built up on the scale of 1:40,000.

The experience gained by Capt. Hamshaw Thomas, in making this flying map of Palestine, seemed to be applicable to civil uses, and the problem was taken up at Cambridge by Prof. Melvill Jones and the late Major J. C. Griffiths. The piloting was throughout in the hands of Flight-Lieutenant F. H. Coleman, Flying-Officer C. E. H. Allan, and Flight-Lieutenant D. L. Blackford. Those carrying out the experiments were always in close touch with Capt. Thomas. The investigations

were commenced in the autumn of 1920, and by the spring of 1923 enough had been done to justify the publication of the results and conclusions. Prof. Melvill Jones and Major Griffiths collaborated in the preparation of the book under review, but, alas! in October 1923, Major Griffiths was accidentally killed whilst flying at Coventry, and it has remained for Prof. Melvill Jones to complete the book alone.

The essence of the method described is the flying in straight courses, at a uniform height above ground, with wings level. Pioneer investigations of this kind must have a beginning, and the choice of the fairly flat country near Cambridge as a site for the experiments was a very wise one. It was certainly not desirable to complicate the problems involved by experimenting in a mountainous region. For it was not only desired to ascertain what accuracy could be reached, but also to examine into the character of the errors involved in the process, and to determine what kind of training was necessary—for the success of the method chiefly depends upon the pilot.

In the flying, one of the chief necessities is to cover the ground with photographs without any gaps, and the best way to effect this is to take the photographs during a series of parallel, straight flights. The book describes very clearly the difficulties that are met with in trying to accomplish this; not the least being the effect of horizontal acceleration in altering the pilot's estimation of the vertical. Then we have the necessity of flying over selected lines, the effect of the roll of the aeroplane, and so on. The method actually used was that the pilot "should bring his aeroplane accurately over a given point at the start of the photographic flight and, henceforward, proceed in the required direction by compass . . . without reference to the ground." It is abundantly clear that only specially trained men are likely to be successful.

As to the making of the map, the photographs are uncorrected, and are fitted together by an ingenious system which is fully described. The height of the aeroplane was usually about 10,000 feet above the ground; if local differences in level do not greatly exceed one-twentieth of the height of the aeroplane—say 500 feet in this case—the map is not seriously affected. Photographs were taken for these experiments over the Bedford level, and the tilt, azimuth, and height were determined, in order to study the elements of error. A series of most interesting diagrams is given, showing in eleven cases the actual plan of the track, the variations in azimuth of the aeroplane, its fore-and-aft and lateral tilts, and its variations in height. The net result is that it is possible to fly an aeroplane so that the tilt shall seldom exceed 2° , whilst the height seldom varies more than 100 feet from the mean value. The

lens usually employed in the camera had a focal length of 6 inches, so that the scale of the photographs was about 1 : 20,000. Attached to the book is the resulting "mosaic" of 225 square miles on the reduced scale of 1.53 inches to 1 mile. As to the errors of the mosaic, a ten-mile square mosaic, of flattish country, should not show positional errors, when "fitted" to an accurate map, of more than a hundred yards.

A long chapter deals with navigational mapping and the joining up of mosaics. There are also excellent chapters on equipment and training, and useful mathematical appendices. It is an indispensable book for those interested in the subject of air survey.

C. F. C.

The Aborigines of Central and North Australia.

The Australian Aboriginal. By Dr. Herbert Basedow. Pp. xx+422+56 plates. (Adelaide: F. W. Preece and Sons, 1925.) 30s.

DR. H. BASEDOW has had exceptional opportunities for studying the mode of life and the customs of the aborigines of Australia, since in the exercise of his duties as State Geologist, and later as Chief Medical Officer and Chief Protector of the Aborigines for the Commonwealth Government in the Northern Territory, he has travelled widely and come into intimate contact with the natives. He has published a few papers on the anthropology of the Australians, and now presents us with a more comprehensive account of his observations on the natives, mainly of those of the Northern Territory. For reasons which he states in the preface, he has not consulted the previous literature, and thus he goes over ground which has been well covered by Spencer and Gillen in "Native Tribes of Central Australia" and "Across Australia," and by Spencer in "Native Tribes of Northern Territory." The reader therefore has to compare these four volumes in order to see where they agree and where differences occur, and in the latter case he will have to make up his own mind which is the better version.

The volume affords an excellent general survey of the ordinary life of the native, and where necessary the differences between various tribes are pointed out. The racial characteristics are dealt with fairly fully, but no measurements are given. The chapter on the "Likely Origin of the Australian Aboriginal" is by no means so satisfactory. The accounts of various mutilations and other subjects which would appeal to a medical observer are of value. The section dealing with social organisation is weak and of no interest to a student, and that on language is not much better;

the author does not appear to be acquainted with the work of Pater W. Schmidt.

There are some valuable suggestions in the chapter on religious ideas. Although phallic emblems have been found in various parts of Australia, the author claims that he was the first to observe ceremonies connected therewith. He says:

"One often reads, and I was under the same impression myself until I became better acquainted with the tribes, that the Australian natives do not connect the knowledge of conception with any intercourse which might have taken place between the sexes. This I find is not altogether correct, although usually the younger people are kept in complete ignorance of the subject. No doubt strangers are treated similarly when they put any pertinent questions to the old men on matters of sex. The old men believe in the duality of human creation, the spiritual and the material; sexuality is regarded as the stimulus of corporeal reproduction, but the spirit quantity is derived through mystic and abstract influences controlled by a 'totem'-spirit or Knaninja" (pp. 284-5).

Carveth Read says: "So far as ignorance exists, it is due to repression by opposing doctrines and desires" (Journ. Roy. Anthropol. Inst., 1918), and the psycho-analytic view has recently been stated by Roheim in "Australian Totemism." The author gives some information about the manufacture of stone implements.

The best chapter in the work is that on aboriginal art, in which the author gives numerous illustrations and elucidates the meanings of the designs; it will be seen by comparing these with the explanations given by Sir Baldwin Spencer that the same design may have several interpretations. The book is well illustrated, and it will have a lasting value as a record of the investigations of an independent observer. A. C. H.

The Mystery of Rhythm.

What is Rhythm? An Essay. By Prof. E. A. Sonnenschein. Accompanied by an Appendix on Experimental Syllable-Measurement, in which Stephen Jones and Eileen Macleod have co-operated. Pp. viii + 228. (Oxford: Basil Blackwell, 1925.) 10s 6d net.

PROF. SONNENSCHIEIN has made a substantial contribution to the subject of rhythm. There are very few persons who could have written this book, which shows a scholarly familiarity with the verse of many languages, with music, with phonetics, and with psychology.

In Chap. i. Prof. Sonnenschein leads up to a definition of rhythm by way of a discussion of the definitions offered by his forerunners—a discussion which brings home to the reader how necessary it is in all branches of exact knowledge to define our terms, if we are to

avoid confusion of thought. Not a few controversies have arisen through a want of clearness, or from ambiguity in the essential terms used in the debate itself. Prof. Sonnenschein's definition is a development and, as we think, an improvement of that of the Greeks; it reads:

"Rhythm is that property of a sequence of events in time which produces on the mind of the observer the impression of proportion between the durations of the several events or groups of events of which the sequence is composed."

This is comprehensive; and it stands the "pragmatic test" when applied to various manifestations of rhythm dealt with in the subsequent chapters—rhythm in music, in isosyllabic verse, in Greek, Latin, French, and English verse. In all these fields Prof. Sonnenschein shows a wealth of learning and a minute acquaintance with previous research which commands the respect of the reader.

In his treatment of English verse the author strikes out on original lines, but a pleasing feature of his writing is its urbanity of tone.

The "war of the prosodists" has become a by-word: Prof. Sonnenschein, however, in differing from Dr. W. Thomson, Prof. Saintsbury, and the Poet Laureate, does so with moderation and courtesy. The most original and distinctive feature of his theory of English verse is that it is based on experimental observations, for he has measured the actual durations of the vowel sounds and of the consonantal sounds in hundredths of a second by means of the well-known physiological recording instrument, the kymograph. In this research Prof. Sonnenschein has been helped by the Superintendent of the Phonetics Laboratory at University College, London.

The results are summarised in Chap. viii.—"Syllable Measurement in English"—where we find simple and intelligible rules of quantity in English syllables based on the distinction between the relatively short and the relatively long, and analogous to the rules of quantity with which every schoolboy ought to be familiar in his Greek and Latin. Phoneticians and prosodists alike will have to study these experimental results, since they place the whole matter on an objective and statistical basis.

A shorter if less exact definition given is—"Rhythm is a recurrence of similar phenomena at regular intervals of time." This excellent "working" definition rules out of court the so-called "irregular" rhythms, which are, strictly speaking, contradictions in terms.

We venture to think that this treatise would have been made still more interesting and "popular" in the best sense of the word if, in an introductory chapter, the author had alluded to some of the rhythms in

Nature—the rhythms of the heavenly bodies, and the rhythms of the earthly. Rhythm rules in the interstellar spaces, rhythm throbs through living beings. A study of these cosmic and vital rhythms, respectively, teaches us that the absolute time-interval between the “events” is not of the essence of rhythmicity; for there is as true a rhythm in the return of a comet or the repetition of an eclipse, which involves years, as there is in the rhythm of the beating heart where, between successive systoles, there are only a few fractions of a second.

There is much to interest the psychologist in Prof. Sonnenschein's treatise, while the physiologist can learn something in it about the physics of speech. It would not be true to say that this book is easy to read, no work involving so much detail about a not very familiar subject could possibly be easy to read: but it is an enduring monument to the patience, the scholarship, and the fine appreciation of music and poetry on the part of the former professor of Greek and Latin in the University of Birmingham

D FRASER HARRIS.

Our Bookshelf

(1) *Fishes* By David Starr Jordan. Revised edition. Pp xv+773+18 plates (New York and London: D. Appleton and Co., 1925.) 30s net.

(2) *The Fishes of the British Isles, both Fresh Water and Salt* By Dr J Travis Jenkins (Wayside and Woodland Series.) Pp vii+376+143 plates. (London and New York: Frederick Warne and Co., Ltd., 1925.) 12s 6d. net.

(1) D. JORDAN's book on fishes, in two volumes, issued in 1904, was reviewed in NATURE soon after it appeared (vol 72, p. 625, October 26, 1905). The present work, in one volume, does not call for an extended notice, as it differs from the former one only in the omission of certain chapters or sections of chapters. Of the thirty-five chapters in the first volume of the 1904 edition, eighteen have been left out entirely, and parts of four others; but nearly the whole of the second volume is retained. The book has evidently been reprinted from standing type and to describe it as a revised edition is misleading. There is one new paragraph (p. 184) inserted because the fitting together of parts of two chapters of the original book left a space that had to be filled; this paragraph refers to the recent discovery of a rudimentary sixth gill-arch in *Heterodontus*, and includes the statement that “the presence of five species in the *Squalidae* perhaps indicates affinity with *Heterodontus*”, here “five species” should obviously be “fin-spines”.

(2) There is no modern work on British fishes, and Dr. Jenkins has attempted to supply this need by producing what is described as a handy pocket volume, dealing with the characteristics and habits of British fishes, both fresh-water and salt. The book is illustrated by so many as 143 plates, nearly half of which are coloured; most of the coloured representations of

marine fish are reproduced from Smitt's “Scandinavian Fishes,” and most of those of the fresh-water species from Grote, Vogt and Hofer's “Fresh-water Fishes of Central Europe.” A number of the uncoloured figures are taken from Day's “Fishes of Great Britain and Ireland”; some of these are good and some rather poor, for although all the plates in this work were inscribed as drawn by Day, he employed two lithographers, one of whom was far superior to the other.

With the aid of the illustrations, and of the short diagnoses given by the author, the owner of Dr Jenkins's book should be able to identify any fish he is likely to catch in British waters; having done so, he will find a certain amount of information about it, which may or may not include what he wants to know, as the treatment of the different species is rather unequal. In general it is the important food-fishes, such as the herring, cod, and plaice, that are most fully dealt with, and it is in his account of these that the author is most convincing.

The classification is nearly that of Gunther's Catalogue, it is a little surprising to find a modern work on fishes beginning with the perch and ending with the *Chimæridæ*—these, we are told, “connect the cartilaginous fishes (Sharks and Rays) with the Ganoids (Sturgeons).” Even in the arrangement of the species there is often no regard to relationships: for example, the coal-fish and pollack are separated by the whiting, and the skate and the long-nosed skate by the bottlenosed ray. This is, in our opinion, the most serious defect of the book.

C. T. R.

Reports of the Progress of Applied Chemistry Issued by the Society of Chemical Industry Vol 9, 1924. Pp 700. (London: Society of Chemical Industry, 1925.) 7s. 6d., to non-members, 12s. 6d.

THE ninth volume of these reports follows closely on the lines of preceding issues; it contains eighty more pages than the report for 1923, a report on the non-ferrous metals is not included, but that on photographic materials and processes makes a welcome reappearance. The occurrence of such slight changes suggests that, on occasion, nothing is lost by making a report cover a longer period than one year. Space is saved, and the writer has a better chance to delineate the wood as well as the trees. Although the mass of material dealt with in each report is always great, the actual progress achieved is by no means always proportionate. In reading these reports, one is struck by the prodigious activity of those who are working to harness chemistry to industrial uses—in the present report, well over 3000 names appear in the name-index—and for this reason it is obviously impossible to give more than a cursory survey of most of the subjects treated. If the present increase in output continues, the annual volume will soon become unwieldy, and something in the nature of a quinquennial revaluation and digest will be called for, but the work of condensation would not be easy, as writers of the calibre of Hazlitt (who condensed seven volumes of Tucker's “Light of Nature Pursued” into one) are not common in the chemical profession. On the whole, it would appear better to issue such summaries in the form of monographs—a practice which has found favour in Germany.

No serious student of chemical technology can fail

to be interested in one or more of these excellent reports, the diversity in length of which varies far more than their merits. The report on plant and machinery is usually the least meritorious, mainly because sketches and diagrams are always omitted. This year the reporter has succeeded in infusing some life into the subject, although in doing so he has had to go a little outside his proper ambit. Among the subjects of up-to-date and general interest treated in the other reports are: low-temperature carbonisation, nitrogen-fixation (discussed by four writers), insecticides (a new and valuable feature), vitamins, preservatives in food-stuffs, and cinematography. Misspelt words are rather more numerous than one would expect in a work of this standing (e.g. "contributions" in lieu of "contributors" on the page facing the Contents, "molton," p. 57, "ashphalt," p. 99, "napthalene," p. 108); the use or non-use of hyphens is somewhat erratic (e.g. "cheap zinc blende acid," p. 180); and future issues might well include a list of the full titles of the journals referred to in the text, as some of them are little known and difficult to obtain.

Thamyris: or, Is there a Future for Poetry? By R. C. Trevelyan. (To-day and To-morrow Series.) Pp. v + 89. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., n.d.) 2s. 6d.

MR. TREVELYAN has written a careful and penetrating study of the present position of poetry, and of its possible—he is too hesitant to justify the word probable—development in the future. Superficially, the prospect is not hopeful. The dissociation of poetry from music and intonation, and the fact that poetry uttered to-day is spoken, not sung, coupled with the further fact that it is usually not uttered at all but silently read, cannot but have the effect of impairing the force of its emotional and purely sensuous appeal. The growth of the scientific habit of mind, expressing itself in prose as its appropriate medium, and the competition of the cinemas and broadcasting, are further influences tending to the supersession of poetry as the normal method of emotional communication between man and man.

At the same time, Mr. Trevelyan contends, poetry fulfils a function, which, so long as the heart of man remains fundamentally unchanged, will lead him still to find the satisfaction of certain ideal and imaginative needs in poetry, whatever may happen to his head. As opposed to prose, which depends for its significance primarily upon the intellectual content of the matter communicated, the value of poetry resides in the beauty of the medium itself, so that if poetry were proscribed by Act of Parliament, we should find ourselves trying to make shift with a clumsy substitute for it in the form of rhythmical prose.

The danger to poetry, which, driven off the popular stage by music, hurry, and the cinema, is forced to make its appeal to the cultured and leisured few, is that it should become precious and obscure, seeking in far-fetched allusiveness and merely verbal nicety to compensate for its divorce from the flowing stream of popular life. This danger, already manifest to-day, is likely to grow in the future, unless poets can find a new source of inspiration in the changing needs and interests of the time and the new aspects of the world revealed by modern science.

Industrial Poisons in the United States. By Prof. Alice Hamilton. Pp. x + 590. (New York: The Macmillan Co., 1925.) 21s. net.

DR. HAMILTON writes with the authority which comes from great experience of diseases arising from the manufacture and use of poisonous substances, and it is satisfactory to learn from her that, on the whole, the incidence of such diseases is diminishing.

More than one-third of the book is devoted to lead poisoning; a good account is given of the industrial processes in which this hazard is experienced, the toxic symptoms are fully discussed, and the numerous controversial points are stated fairly and reasonably. The other inorganic poisons are dealt with similarly, and it is interesting to note that most of the modern industries have brought in their train new problems of this kind. Thus the alloys required for special steels have introduced manganese and vanadium poisoning, and the Mond nickel process has led to poisoning cases with nickel carbonyl.

Both in Great Britain and the United States the development of the fine chemical industry has brought the industrial physician into contact with new problems due to the toxicity of raw materials and intermediates used in producing dyes and explosives, and if the chemist is to help him in solving these, it is important that they should understand each other. Dr. Hamilton, unlike many of her medical colleagues, is reasonably familiar with chemical processes; rarely does she fail to use the tribal language of the chemist accurately, and she always translates factory slang into English. Even the academic chemist can, therefore, read this work with pleasure and profit, and if he is inclined to assist in biological and pathological investigations, he will find many problems suggested to him in its pages.

The author refers so constantly to European, and especially to British literature on this subject, that the book might well have been called "Industrial Poisons" without the geographical limitation implied in its present title. The one exceptional substance is "wood spirit," which is probably an industrial poison only in the United States, and that for peculiar and well-understood reasons.

T. A. H.

Ionisation et résonance des gaz et des vapeurs. Par Dr. Léon Bloch. (Recueil des Conférences-Rapports de documentation sur la Physique. Vol. 11, 2^e Série. Édité par la Société *Journal de Physique*.) Pp. 223. (Paris: Les Presses universitaires de France, 1925.) 25 francs.

IN few subjects is the difficulty of interpretation of the experimental evidence greater than in that which deals with the resonance and ionisation potentials of gases. It is, however, of such importance to the theory of atomic structure that a clear and critical survey of its present stage of development is to be welcomed. Such an account is to be found in the volume under notice. Prof. Bloch is well aware of the many pitfalls which beset the path of the experimenter and of the danger of too much speculation on too slender an experimental basis. He insists, again and again, on the fact that, without spectroscopic confirmation, the interpretation of the electrical measurements must always be somewhat uncertain.

The early chapters deal with the experimental

technique and the measurements of monatomic gases and vapours. It is here that the greatest success has been achieved in the association of critical potentials with the single line, double line, arc and spark spectra. Of particular interest is the evidence for the existence of atoms in metastable states. The possibility of a change from one state to another slightly less stable is likely to prove one of the most helpful ideas in the interpretation of both critical potentials and spectra. The diatomic gases present a much more difficult problem, as these molecules may dissociate or be disturbed in so many different ways.

The final chapters deal with the photoelectric effect and the statistical equilibrium between atoms, electrons, and radiation. The author points out the ever-increasing importance of the Wilson track photographs in this field. This volume, which forms the eleventh of the series of monographs issued under the auspices of La Société *Journal de Physique*, fully maintains the high standard set by its predecessors.

Forme della terra. Trattato di geologia morfologica (Geomorfologia). By Prof. Gaetano Rovereto. Vol. 1: *Basi e generalità.* Pp. xv + 641 + 16 tavole. Vol. 2: *Tipi regionali.* Pp. viii + 645 + 1188 + 22 tavole. (Milano: Ulrico Hoepli, 1924-25.) 150 lire.

PROF. ROVERETO, of the University of Genoa, has prepared an elaborate and beautifully illustrated textbook of geo-morphology which should be of wide service to geologists and geographers, owing to its authoritative account of the physical geology of Italy, its copious bibliographies thereon, and its clear explanation of Italian geological terminology. It also includes a wide selection of references to the cosmopolitan literature on the subject. As might be expected from the previous contributions of the author, the volume draws many illustrations from South America, and the section on mountain structure, which is illustrated by an instructive map of the tectonic divisions of Italy, is of especial interest.

The first volume deals with the general principles and processes of physical geology, and the second describes the chief regional types due to them, including coast lands, volcanic regions, glaciated areas, karsts and deserts, plains and mountains. The classifications adopted are in many cases more artificial and elaborate than those used by British geographers, but the book should be the standard authority in Italy, and elsewhere a convenient work of reference to recent work on the exceptionally interesting geography of the Italian peninsula.

The Vegetation of Burma from an Ecological Standpoint. By Prof. L. Dudley Stamp. (University of Rangoon Research Monographs, No. 1.) Pp. vi + 65 + 28 plates. (Calcutta: Thacker, Spink and Co., 1925.) 7 rupees.

THIS is one of the first presentations of a study of the vegetation of a British tropical dependency, based on present-day ecological methods. The author, in collaboration with Mr. Leslie Lord, has already given a more detailed study entitled "Part of the Riverine Tract of Burma." The present work shows this area in relation to the rest of the country and provides a general review of the distribution of the vegetation

and its controlling factors. Of these, the chief are elevation, climate, and geology and soil. A brief discussion is given of the effect of each of these, after which the author enumerates, with brief descriptions, the main types of vegetation and their natural relationships. These types are classed under mountain vegetation with six types and lowland vegetation with twenty-five types. Four seral medial stages are also noted. The inter-relationships of the types are graphically indicated in tabular form, where it is clearly seen that with a very high rainfall soil has little effect, but with a rainfall of 40 inches and less its influence is paramount. The discussion on geology and soils is in more detail, and the general relationship of geology and ecology is discussed and summarised in the concluding chapter. The book is accompanied by several maps reproduced as text figures, and is profusely illustrated with photographs of the various types of vegetation discussed.

An Introduction to Economic Geography. By Wellington D. Jones and Derwent S. Whittlessey. Vol. 1: *Natural Environment as related to Economic Life.* Pp. xxxvii + 375 + 225 plates + 7 maps. (Chicago: University of Chicago Press; London: Cambridge University Press, 1925.) 5 dollars.

IN spite of its large size, this book covers only a small part of economic geography. It claims to deal in outline with the several factors of the natural environment as they affect human life. A second volume is to treat of the chief economic activities in relation to natural environment. The plan of the book is novel. In the first part a number of exercises are set which the student is to work out by reference to the "textual materials" in the second part and the illustrations and maps in the third part. Atlases, topographic maps of the United States, and outline maps are also to be used. The textual materials are short paragraphs and extracts from authoritative works dealing with different aspects of the subject. The exercises are well planned, and the paragraphs in Part 2 are accurate and fairly representative, and the book may be regarded as a useful introduction to the subject. Examples are mainly drawn from America. Illustrations and maps are clear and well chosen, and a full index is provided.

Block Diagrams and other Graphic Methods used in Geology and Geography. By Prof. A. K. Lobeck. Pp. xi + 206. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 22s. 6d. net.

THE value of block diagrams in geographical and geological instruction cannot be questioned, but many teachers find these difficult to draw, especially on the blackboard, at short notice. Prof. Lobeck has written a volume that should prove most helpful and deserves to be widely known. By the help of several hundred diagrams and sketch maps, he explains the value of perspective and the construction of diagrams from maps and illustrations. Examples of various land forms are given, and it would be a dull teacher who fails to gain something advantageous from a study of the pages. Later chapters deal with isometric diagrams, sketching from photographs, and crystal drawing. Each step in the development of the art has a number of instructive practice exercises.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

An Early Reference to Mendel's Work.

THE rediscovery of Mendel's classic "Versuche über Pflanzen-Hybriden" must undoubtedly be attributed to the references made to it by Focke in his "Pflanzenmischlinge" (Berlin, 1881). As Dr. Iltis points out in his recent life of Mendel, the fresh movement towards crossing experiments at the end of last century inevitably sent workers to the "Pflanzenmischlinge," where, unless they were either hasty or careless, they could scarcely fail to come across one or more of the half-dozen references to Mendel's name. But how came Focke to light upon a paper which was so securely buried? Apparently Dr. Iltis propounded this question to Focke himself, who replied that he had come across it in the literature of 1870, but could not then say where. ("Auf Mendels Arbeit bin ich durch die Literatur der 70er Jahre aufmerksam geworden, kann aber nicht sagen, wo ich sie erwähnt gefunden habe"—Iltis' "Life of Mendel," p. 204).

I wish to suggest that the reference which escaped Focke's memory is to be found in H. Hoffmann's "Untersuchungen zur Bestimmung des Werthes von Species und Varietät," Giessen, 1869. On p. 136 of this work Hoffmann refers to Mendel's "sechsjährige Beobachtungen," though for him the point of most interest appears to have been the evidence that Pisum is generally self-fertilised. Mendel's results are dismissed in the brief sentence "Hybride besitzen die Neigung, in den folgenden Generationen in die Stammarten zurückzuschlagen." Prof. Hoffmann was evidently looking for something else.

It is worthy of note that he makes no mention of Mendel's experiments with Phaseolus, though a considerable part of his essay is taken up with his own experiments in growing and crossing different forms of this genus. These experiments of Hoffmann are discussed by Darwin in his "Cross- and Self-Fertilization" (2nd edition, 5th impression, p. 151), so that Darwin must have had in his hands a brochure which contained a reference to Mendel's work only four years after its publication. R. C. PUNNETT.

Whittingehame Lodge,
Cambridge.

Valence Theories and the Magnetic Properties of Complex Salts.

NATURE of September 5, containing the letter of one of us and the courteous criticisms of Dr. Jackson, reached the library of the Institute at the very time that we were engaged in a task suggested in Dr. Jackson's note. When writing on July 23, we were of the belief that it would be impossible to explain magnetic anomalies in complex salts until detailed information should become available regarding the orientations of the orbital planes. It was the explanation given by Oseen¹ of Ingersoll's non-magnetic nickel which suggested to us that the problem might be simpler. It suggested that we need only to consider the number of electrons in certain levels associated with the central metal atom, and that we may, for the present purpose, disregard the matter of orientation.

¹ Zeit. f. Phys., 1925, 32, 940.

The Kossel and Lewis-Langmuir valence theories are a guide in determining the number of electrons which the central atom of the complex may obtain from or give to the groups or radicals in the compound. They have been used with success by several investigators to account for the behaviour of complex salts as electrolytes. We have made most use of a paper by Sidgwick,² but the reader should consult also the papers of Lowry,³ Spiers,⁴ and Brockman.⁵ The ideas of electron sharing, or rather the sharing of orbits, and of electron transfer are explained and illustrated with examples by Sidgwick. Here we shall merely list the number of electrons given to or taken from the central atom by the groups or radicals.

Each NH_3 , OH_2 , C_2O_4 and $\text{OC}(\text{NH}_2)_2$ adds 2 electrons, 1 by sharing and 1 by transfer.

The $\text{en} = \text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$ and $\text{pn} = \text{NH}_2\text{CH}_2\text{CH}(\text{NH}_2)\text{CH}_3$ groups add 4 electrons each.

Each univalent radical CN , NO_2 , Cl , SCN , etc., within the complex adds 1 electron by sharing. The same radicals outside of the complex remove 1 electron by transfer. Similarly, the divalent SO_3 and SO_4 each remove 2.

K and Na add one by transfer.

Finally, it can be deduced from the "octet" theory that CO contributes 2 electrons by sharing, and that NO , when it enters the complex, contributes 3, 1 by transfer and 2 by sharing.

We shall now apply this scheme of addition and removal to many of the salts which have been studied magnetically, considering first the diamagnetic salts of iron. The iron, with 26 electrons, in the salts $\text{K}_4\text{Fe}(\text{CN})_6$, $\text{Na}_3\text{Fe}(\text{CN})_5\text{NH}_3$, $\text{Na}_4\text{Fe}(\text{CN})_5\text{NO}_2$, $\text{Na}_2\text{Fe}(\text{CN})_5\text{NO}$, and $\text{Fe}(\text{CO})_5$ acquires 10 more, making 36 in all, and thus corresponds to the diamagnetic, rare gas krypton. The formula for another diamagnetic salt $\text{Na}_5\text{Fe}(\text{CN})_5\text{SO}_3$ does not seem to be correct from our present point of view. From this view-point, also, $\text{Na}_3\text{Fe}(\text{CN})_5\text{OH}_2$ should be diamagnetic. As mentioned in the previous letter we have had trouble with this salt, and some samples have been nearly neutral towards the magnet.

Next, consider the 64 cobalt compounds measured by Rosenbohm.⁶ All but two are diamagnetic. The two exceptions are so slightly paramagnetic that the magneton number may be taken to be zero. Disregarding 8 of these cobalt compounds which are, as Rosenbohm remarks, of doubtful composition, we find, in all cases, that the cobalt atom acquires 9 electrons and attains the krypton configuration of 36.

The same investigator measured three salts of ruthenium and two of rhodium. In these the metal atom takes on the configuration of xenon, atomic number 54, since ruthenium obtains 10 electrons and rhodium 9 from the attached groups and atoms. He found the salts of iridium and of quadrivalent platinum to be diamagnetic. Considerations such as the foregoing show that iridium, atomic number 77, and platinum, atomic number 78, acquire 9 and 8 electrons, respectively; thus achieving the configuration of neon with 86 electrons. Two of Rosenbohm's four platinum salts in which the metal appears to be divalent, indicate that 6 electrons are added, giving the configuration of polonium with 84 electrons. We do not care to venture an opinion as to the possibility of the polonium configuration; nor are we informed as to its magnetic properties.

It is interesting to note that $\text{Ni}(\text{CO})_4$, which, according to Oxley, is diamagnetic, and $\text{K}_3\text{Co}(\text{CN})_6$,

² Jour. Chem. Soc., Trans., 1923, 123, 725.

³ Chem. and Ind., 1923, 42, 316.

⁴ Chem. and Ind., 1923, 42, 534.

⁵ Chem. and Ind., 1924, 43, 756.

⁶ Zeit. f. phys. Chem., 1919, 93, 693.

which we found to be diamagnetic, both lead to the configuration of krypton. In concluding this discussion of the diamagnetic salts, it may be mentioned that the nearly diamagnetic substances KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ yield the configuration of argon if each oxygen removes 2 electrons and each potassium adds 1.

A slightly different treatment is required in the case of salts giving magneton numbers which are not zero and are different, very often, from the numbers obtained with the simple salts. Let us assume the existence of stable configurations other than those of the rare gases and let us see how the magneton numbers we may expect agree with the experimental values. Consider the ferric compounds, $\text{K}_3\text{Fe}(\text{CN})_6$, $\text{Na}_2\text{Fe}(\text{CN})_5\text{NH}_3$, $\text{Na}_3\text{Fe}(\text{CN})_5\text{NO}_2$ and $\text{Na}_2\text{Fe}(\text{CN})_5\text{OH}_2$. In these salts the iron atom acquires 9 electrons. Taking liberties in the distribution of electrons among the levels, we may assign 5 of the 9 to the N level, thus making it complete with 8, and then we shall assign the remaining 4 to the M level, giving us 17 in all in that level. This is exactly as required by the Bohr scheme in divalent copper, and divalent copper shows 9 to 10 magnetons in its simple salts. This is in fair agreement with the magneton numbers we have assigned to most complex ferric salts, considering the uncertainties in our numbers and the still rather large uncertainties about the divalent copper ion.

Rosenbohm made observations on many chromium complex salts and found in general 19 magnetons. The central atom acquires 9 electrons. Assigning 5 to complete the N level of trivalent chromium, we have 4 left to add to the 11 already in the M level. This corresponds to the M level of divalent cobalt. Experimentally, the divalent cobalt ion in simple salts gives 24-25 magnetons, but it is apparently anomalous and we should expect 19, as indicated in Fig. 2 of Sommerfeld's paper, in which this anomaly is noted.

Seven of the nine nickel salts measured by Rosenbohm gave about 16 magnetons. The nickel atom obtains 10 electrons, which, added to its own 28, give the 38 corresponding to strontium. We have no magnetic data for strontium, but it is fair to infer that it is analogous to neutral calcium, which has been assigned 2 Bohr magnetons or 14.1 Weiss magnetons by Sommerfeld.

The copper salts of Rosenbohm gave 9 magnetons, and, according to the scheme proposed in this letter, the central atom gains 6 electrons. It will correspond to bromine of atomic number 35. Taking, again, the liberty of first filling up the N level with 8 electrons, we find 17 in the M level, as we do in simple divalent copper ion with its 9 magnetons.

It seems, then, that the chromium, nickel, and copper atoms can be just as "abnormal" in their complex salts as are those of iron, cobalt, and the others we have considered. The fact that we find in complex salts of chromium, nickel, and copper the same magneton numbers as in the simple salts, is due to the peculiarities or, perhaps better, to the orderliness of atomic structure and of the periodic system.

It is evident, if the assumptions which have been made can be maintained, that we have not only a solution of the problem of magnetic anomalies in complex salts, but also quantitative support for certain current theories of chemical valence.

LARS A. WELO.
OSKAR BAUDISCH

Rockefeller Institute for Medical Research,
New York, September 17.

Zet. f. Phys., 1923, 19, 221.

NO. 2921, VOL. 116]

Carnot's Cycle and the Efficiency of Heat Engines.

IN a paper on Carnot's Cycle and the Efficiency of Heat Engines, reported in *NATURE*, August 29, Dr. J. S. Haldane comes to the astonishing conclusion that "the Carnot cycle is radically inefficient" and gives a cycle of operations which has convinced him that the maximum efficiency of a heat engine is 50 per cent. Prof. A. W. Porter has already dealt with this claim in its more general aspects (*NATURE*, October 3), but it may be of interest to calculate directly the efficiency of Haldane's cycle and compare it with that of a Carnot cycle working between the same temperature limits.

Dr. Haldane takes a cylinder containing water and some aqueous vapour at the pressure corresponding to its temperature T_1 and carries out a cycle of operations consisting of three stages. (1) The temperature is raised to T_2 while the volume is kept constant. (2) The system is allowed to expand

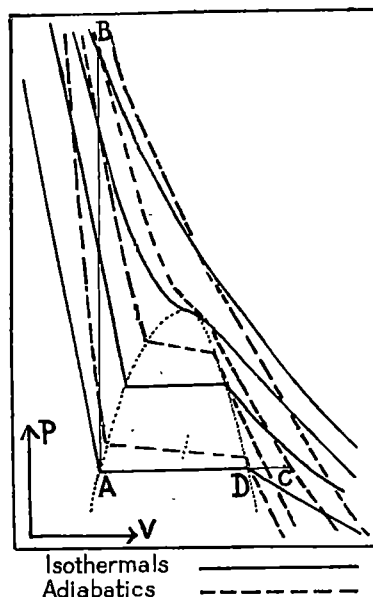


FIG. 1.

adiabatically until the pressure has fallen to the original pressure p_1 . (3) It is brought into its original state by means only vaguely specified.

The nature of this cycle of operations will be gathered from Fig. 1.

With such a liquid-vapour system, a number of different cases are possible depending on the relative proportions of liquid and vapour, and on the temperature difference. We shall take a case (ABCD) in which complications in the calculation are reduced to a minimum.

We have then the following heat and work terms in the various stages.

(1) AB. Heat absorbed $\int_{T_1}^{T_2} C_p dT$. No work done.

(2) BC. Adiabatic expansion. Work done A . No heat absorbed.

(3) CD. Combination of infinitesimal isothermal and adiabatic stages. Heat absorbed $q = \int C_p^* dT$. Work done $-p_1 \Delta v$.

(4) DA. Isothermal condensation of vapour. Work done $-p_1 \Delta v$. Heat absorbed $-L$. (L = latent heat of vaporisation of liquid at T_1 .)

Equating the sum of the heat and work terms for the whole cycle to zero, we have :

$$\int_{T_1}^{T_2} C_v dT - L + q - (A - p_1 \Delta'v - p_1 \Delta''v) = 0.$$

The "efficiency" of the cycle in Dr. Haldane's reckoning, *i.e.* the ratio of the work obtained in the whole cycle to the heat absorbed in stage (1), is

$$E = \frac{A - p_1 \Delta'v - p_1 \Delta''v}{\int_{T_1}^{T_2} C_v dT} = 1 - \frac{L}{\int_{T_1}^{T_2} C_v dT} + \frac{q}{\int_{T_1}^{T_2} C_v dT}.$$

Neglecting the third term, we have, to a first approximation,

$$E = 1 - \frac{L}{C_v(T_2 - T_1)}.$$

For water L is of the order of 540 calories per gram, C_v about 1 cal., therefore a temperature difference of about 1000° would be required for 50 per cent efficiency. The efficiency of a Carnot cycle working between the same temperature difference, for a cold

body temperature of 300° K, would be $\frac{1300 - 300}{1300} = 77$

per cent. Dr. Haldane's cycle is therefore, in this case, considerably less efficient than Carnot's.

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Hermaphroditism in the Portuguese Oyster.

THE Portuguese oyster, *Ostrea (Gryphæa) angulata*, has been studied by many investigators, among others M. Bouchon-Brandley (1882), J. A. Ryder (1882), and J. L. Dantan (1912, 1914, 1918), but no one has ever recorded the occurrence of hermaphroditism in this species. It was believed that the sexes in this species were strictly separate, although other forms of *Ostrea*, such as *O. edulis*, *O. lurida*, and *O. denselamellosa*, are always hermaphroditic.

While studying oysters at the Plymouth Marine Biological Laboratory, I observed two hermaphrodite individuals in a batch of 75 Portuguese oysters, which were sent from Whitstable Oysterage, where they had been relaid and cultured. All the oysters were well-grown, large specimens and were kept alive in the outside tank of the laboratory for some time.

The dates of examination and the distribution of the sexes were as follows :

Date.	♂♂	♀♀	♂♀	
May 29 (1 day after arrival)	2	9	0	
" 30	1	5	0	
June 3	2	3	0	
" 12	2	9	0	
" 14 (examined by Prof. Awati)	1	9	0	
" 15 (examined by Prof. Awati)	1	4	0	
July 3	1	2	1	
" 16	4	18	1	
Total	14	59	2	Σ = 75
Ratio per cent. . .	18.6	78.6	2.6	

The sex-ratio differs from that observed by Dantan (43.6 per cent. ♂♂, 56.37 per cent. ♀♀) who examined a larger number of individuals. Of course, in the present case the numbers examined are not sufficient to warrant any conclusions being drawn, but the figures are worth noting.

The hermaphrodite specimens were examined

whilst fresh under the microscope, and no differences were found in the nature of the eggs and sperm as compared with those taken from normal specimens in which the sexes are separate. The eggs were of the ordinary size and shape, and the sperm exhibited active movement. Sections of the hermaphrodite gonad showed male and female elements in the same tubule. Only mature sperm were present, although eggs were found in all stages of development up to complete maturity; some of the latter were detached from the germinal layer and lay free in the sperm aggregates.

The diameters (μ) of a few of the eggs were found to be as follows: 73 × 86, 75 × 86, 79 × 79, 83 × 86, those of the nuclei being 23 × 26, 23 × 28, 24 × 28, and 25 × 28 respectively; so that the size of the egg is nearly the same as that of other dioecious oysters, and much smaller than that of all the true hermaphrodite forms mentioned above, in which the larger size of the egg is characteristic.

It is also noteworthy that the hermaphrodite specimens were found among animals which had been kept alive in the tank for more than a month, *i.e.* which had endured, so to speak, a prolonged period of starvation.

A parallel example would appear to be that of the American oyster, *O. virginica*, a species in which the sexes are distinct; however, one hermaphrodite specimen has been recorded (Kellog, 1892). It was obtained from a rearing-batch of oysters at the Woods Hole Marine Laboratory. In view of this, I am inclined to suggest that possibly there exists some relation between nutritive conditions - and hermaphroditism in those species of oysters in which the sexes are as a rule separate.

IKUSAKU AMEMIYA
(Tokyo Imperial University).

Animal Breeding Research Dept.,
The University, Edinburgh,
October 2

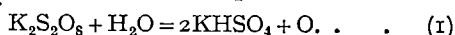
Apparently Anomalous Protection against Oxidation.

IN his address on "Catalysis and Oxidation," printed in NATURE for August 22, Prof. Henry E. Armstrong refers to surface peroxidation of metals as affording protection against further oxidation.

An interesting example of the interference of oxygen with oxidation came to my attention recently. In the course of a technical investigation of the blackening of copper, brass, and bronze in potassium persulphate solutions, it was noticed by my assistant, Mr J. Schmitt, that when the strip of metal was dropped into the solution it blackened readily and completely. If, however, it was slowly lowered into the solution, at rates up to 14 linear inches per minute, blackening either did not take place or was very patchy and imperfect, generally not more than a tarnish.

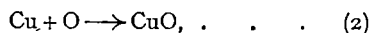
E. Groschuff, in a valuable article on the blackening of copper and copper alloys by alkaline persulphate solutions (*Deutsch-Mechan. Zeit.*, 1910, p. 135), notes disturbances coming from oxide layers "which on account of their impermeability prevent the action of the colouring bath," and cites in this connexion the experiments of E. Muller (*Zeit. f. Elektrochem.*, 13, 137 (1907)) on passive copper, but does not note that a disturbing tempering layer may form on freshly cleaned metal if lowered slowly into the alkaline persulphate bath. The interference is still more marked with copper alloys than with pure copper. The solution used for this process is an alkaline solution of potassium persulphate, *e.g.* 1 to 2 per cent.

$K_2S_2O_8$, with 2 to 3 per cent. KOH. The persulphate is hydrolysed, according to the equation

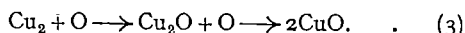


The excess alkali neutralises the acid salt and prevents the solution from becoming acid. Investigations on the velocity of decomposition of persulphate solutions (Green and Masson, J.C.S., 1910, 97, 2086; S. E. Sheppard, *Phot. Jour.*, 1921, 61, p. 454; G. I. Higson, J.C.S., 1921, 119, p. 2048) have shown that the reaction is monomolecular with regard to persulphate, so that equation (1) probably represents the course of the reaction, and atomic oxygen is liberated. The initial production of atomic oxygen is in agreement with the oxidation potential of persulphate solutions.

The simplest representation of the blackening of copper by persulphate would be

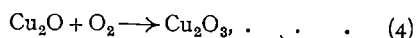


but this undoubtedly only represents the initial and final results. That a more complex process occurs appears to be indicated by the structure of the oxide layer. This is formed as a soft velvety pile, which is not removed by gentle rubbing, but consolidates to a smooth and semi-lustrous layer. A further refinement of the oxidation process is to suppose that cuprous oxide is first formed; it has already been pointed out that the lattice structure of cuprous oxide is nearer that of copper metal than is that of cupric oxide. Hence we may write



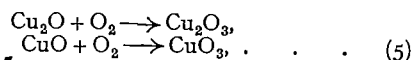
When the metal is slowly lowered into the persulphate solution, it is exposed for a longer time to the air: solution interface. This is the only difference in condition in the two cases. It appeared to me that concentration of molecular oxygen in this layer might be causing the interference. Protection of the surface, as by holding a glass rod against it, while passing the interface, was enough to remove the interference, the protected part blackening normally. Again, if a little antoxidising solution, as hydroquinone-sulphite of soda, were allowed to trickle over the metal just as it entered the persulphate solution, the blackening was of course at first delayed, but soon took place with full vigour. Finally, electrolytic generation of hydrogen at the interface also overcame the interference.

Molecular oxygen is of course accumulating at the interface from the discharge of $O + O \longrightarrow O_2$ produced by the hydrolysis of the persulphate. My tentative explanation of the oxygen interference was that cuprous peroxide is formed:

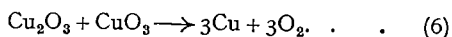


and that this paralyses the reaction, a passive layer being formed.

In line with Mouren's work, it may be possible that both cuprous and cupric peroxides are formed:



and that these decompose each other, with mutual reduction:



Be that as it may, the facts appear to demonstrate another case of the impedance of oxidation by oxygen.

S. E. SHEPPARD.

Research Laboratory,
Eastman Kodak Company,
Rochester, N.Y., September 25.

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The Adult Form of the "Harvest Bug."

THE adult form of the larval mite known as the "Harvest Bug" (*Leptus autumnalis* Shaw), which causes so much annoyance in many rural districts at this time of the year, has long been sought for. In the middle of August, Prof. F. V. Theobald and Mr. C. W. Goode, of Wye, sent me three chickens heavily infested with this larval mite. From these larvæ I have succeeded in rearing an adult mite closely allied to *Trombicula*, Berlese, and resembling that genus in having a deep constriction behind the anterior pairs of legs, but more elongated in form and with the setæ on the cephalothorax shorter and differently shaped. I propose the name *Trombicula* (*Neotrombicula*) *autumnalis* for this adult mite, *Neotrombicula* being a new subgeneric name. The name *Leptus* was created by Latreille for *Acarus phalangi* (= *Achorolophus ignotus* Oudemans), now referred to the family Erythraeidae, and should not be used for the "harvest bug," which belongs to the family Trombididae.

S. HIRST,

British Museum (Natural History),
London, S.W.7, September 26.

Gibbs' Phenomenon in Fourier's Integrals.

PROF. CARSLAW has raised, in *NATURE* of August 29, p. 312, a point which has been interesting me during the past few months. In addition to the case of Fourier's integral which he cites, I have noticed that Hankel's integral

$$f(x) = \int_0^\infty J_\nu(xu) u du \int_0^\infty J_\nu(tu) t f(t) dt,$$

and Titchmarsh's integral¹

$$f(x) = \int_0^\infty H_\nu(xu) u du \int_0^\infty Y_\nu(tu) t f(t) dt,$$

where $H_\nu(z)$ is Struve's function, possess Gibbs' phenomena at points of discontinuity.

This can be shown by a method similar to that given by Prof. Carslaw, using the asymptotic forms for the functions concerned where necessary.

I may add that in the case of Hankel's integral this throws considerable light on the similar problem in the case of Fourier-Bessel series.

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The "Kennelly-Heaviside" Layer.

EVERY radio engineer is familiar with what is called the "Heaviside Layer" and its supposed functions. I find, however, that the hypothesis of an electrically conducting stratum in the upper air was clearly enunciated in an article by Prof. A. E. Kennelly, of Harvard University, published in the *Electrical World and Engineer* of New York on March 15, 1902. The official date of Heaviside's disclosure of his hypothesis is December 19, 1902. About the same date H. Poincaré, A. Blondel, and C. E. Guillaume made similar hypotheses. If names are to be attached to this hypothetical layer it should be called, in equity, the "Kennelly-Heaviside" layer, a name which is beginning to be used in America.

ALEXANDER RUSSELL.

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London, W.C.1.

¹ E. C. Titchmarsh, "Extensions of Fourier's Integral Formula to formulae involving Bessel Functions," *Proc. London Math. Soc.* (2), 23 (1925), xxii. (Records for Jan. 17, 1924.)

The Chemistry of Solids.¹

By Prof. CECIL H. DESCH, F.R.S.

IT is remarkable how little we know with any certainty about the chemical properties of solids, although the idea of a solid is so fundamental. At the present time we always begin the study of chemistry with the gases on account of the simplicity of their mathematical treatment, but it must be remembered that this simplicity is the result of long study and of many discoveries. To the unscientific mind the solid is simpler, because more tangible. When men have tried to understand gases, they have expressed themselves in terms of solids. The atom, however attenuated it may have become in recent years, was in the first instance essentially a solid sphere, and the elasticity of gases has been explained in terms of the collision of elastic solid particles in motion.

Our conception of liquids has been based in the same way on the idea of moving particles, themselves thought of in terms of the solid state. Yet, of solids themselves, whilst our knowledge of their physical and mechanical properties is very extensive, our chemical information is of the most meagre kind. It was an old doctrine that chemical reactions could only proceed in the gaseous or liquid states, so that chemical action on a solid was always preceded by the tearing off of atoms from the surface under the influence of electrical forces. That view can no longer be maintained. Chemical reactions can occur within or at the surface of a solid, but the experimental difficulties are sometimes such as to make the exact investigation of the subject a difficult matter.

In the modern conception of a solid, the atoms are characterised by a regular arrangement in space, that arrangement being repeated so as to build up a crystalline lattice. Crystals and aggregates of crystals are thus the only true solids, glasses being regarded as under-cooled liquids of high viscosity. The X-ray method developed by Laue and by W. H. and W. L. Bragg has made it possible to determine, not only the class of a crystal, but also the exact lattice possible to crystals belonging to that class. The connexion between the chemical properties and the crystalline structure still remains indeterminate, although it must be very intimate.

There are many reasons why the chemical study of solids should receive greater attention. In metallurgy, although metals and alloys may, and most frequently do, pass through a molten stage in the course of their manufacture, they may undergo many important changes of structure and constitution at temperatures far below that at which the last liquid portions have completely solidified, and these changes may be so far-reaching as to convert an alloy into one seemingly of an entirely different class, although the gross chemical composition has not altered. The petrologist, especially when dealing with igneous and metamorphic rocks, has to consider reactions which proceed in the midst of solids of high rigidity. Several industries, such as that of cement, are based on reactions of the same kind as those with which the petrologist has to

deal. Sintering is not always due to the presence of small quantities of molten material between the solid particles, and it is now certain that union of solid masses under pressure may occur without actual melting. This was shown by Spring forty years ago, but for long, although frequently quoted, his results received little consideration.

The most striking application of the principle is seen in the metallurgy of tungsten. This metal was formerly described as very hard and brittle, and it is not possible, by casting it and then annealing, to bring it to a ductile form. The method now adopted is to prepare it in the form of a pure powder, and then to bring it to a compact state by compressing, heating, and hammering while very hot, and finally drawing. As this process is continued, and as an originally thick rod becomes extended into a slender wire, the brittleness progressively disappears, and at last the tungsten is obtained in those beautiful filaments, drawn to extreme fineness, with which we are familiar in our electric light bulbs and wireless valves. A somewhat similar example is that of the adhesion of an electrolytically deposited metal to its support, which is sometimes so perfect as to approach the breaking strength of one of the metals, although interpenetration of crystals is not to be seen under the microscope.

There is another aspect of the chemistry of solids which will make an appeal to some who are not chemists, but amateur students of Nature. The great beauty of natural crystals has attracted the attention of poets and artists as well as men of science. Much of this beauty depends on the varying habit of one and the same crystal species. Even with such a common mineral as quartz, it is possible on entering a mineral collection to point to some of the crystals exposed, and to name their locality, when once the form has become familiar. The same is true of other minerals. Why should there be this variation, when the chemical composition of the distinct varieties may be identical, so far as analysis is able to give information?

Again, the crystalline system will not account for the differences in the building up of individuals to form aggregates. Rock salt and cuprite crystallise in cubes, and the space lattice has a very similar form in the two minerals; but when the salt forms multiple growths, the cubes arrange themselves in characteristic stepped pyramids, whilst the red oxide of copper may form the most beautiful hair-like threads, a tissue of scarlet silk, as Ruskin calls it. Neither mineral ever assumes a form which is characteristic of the other, the simple cube being once departed from. Why should this be? It is known that the presence of traces of foreign matter may cause differences of habit, the most famous example being that of the crystallisation of common salt in octahedra instead of cubes when a small quantity of urea is added to the solution, but the explanation of these facts is still imperfect.

The work of Johnsen and of Gross has shown that the appearance of a face on a crystal placed in a supersaturated solution is really determined by the velocity of growth in a direction normal to that face,

¹ From the presidential address delivered at Southampton on August 31 before Section B (Chemistry) of the British Association.

those faces being produced which have a minimum velocity of growth. Some light is thrown on the subject by a study of the growth of a crystal when solvent is completely excluded, the substance used being sublimed in a vacuum. This has been undertaken by Volmer, who finds that cadmium, zinc, and mercury crystals grow in this way in a high vacuum. When small nuclei are present, those grow which have the face with the smallest velocity of growth perpendicular to the stream of impinging molecules. The differences between different faces are large, so that under these conditions either flat tables or long prisms are usually formed, according to the direction of the original nucleus. The crystal grows by the addition of thin laminae, probably only one molecule thick, which spread over the surface. This is likely to be the process when the crystal is growing in a solution or in a molten mass, as well as in the vapour; and, in fact, when cadmium or tin is being deposited electrolytically at a cathode, or when lead iodide is being formed from a solution of a lead salt and an iodide, the growth of the crystal may be watched under the microscope, when a thin film begins to form at some point on a face, and extends over the face, maintaining a uniform thickness throughout. It is realised that in the presence of a foreign substance, either molecules or ions may attach themselves to such a surface by their residual affinity, and this will necessarily affect the addition of further layers of the original substance. In other words, the velocity of crystallisation in a direction normal to that face will be changed. As the residual affinity of different faces of a crystal must, from the ordinary conception of an atomic space lattice, be different, the habit of the crystal, that is, the relative development of different faces, will be altered by the presence of a foreign substance. It is on these lines that an explanation of differences of habit must be sought.

When a face of a crystal is brought into contact with an etching reagent, such as water for rock salt, hydrofluoric acid for quartz, or cupric ammonium chloride for iron, the surface is not dissolved away evenly, leaving it smooth, but characteristic etching pits are produced, the sides of the pits being evidently crystal faces. This shows that chemical action proceeds more readily along certain planes of a crystal than along others, a fact which we should expect from the general properties of the space lattice. It is not explained, however, why these etching pits should appear at first separate from one another, the intervening portions of the surface being unattacked. Minute particles of some impurity, causing local electrolytic differences, suggest themselves as a possible cause, but it is unlikely that they would be so evenly scattered in, for example, a quartz crystal as to produce the regular distribution which is often observed. Minute inequalities of level, which may be of a periodic character, are more probable, and this suggestion is strengthened by the observation that a polished face of rock salt dissolves evenly in water, whilst a natural cleavage face shows etching pits.

It is now possible, when pursuing the study of solids, to eliminate one of the disturbing factors, the inter-crystalline boundary, by making experiments with specimens composed of a single crystal. There are several ways of preparing single metallic crystals of such a size as to allow of the determination of their

physical and mechanical properties. Even so brittle a metal as zinc has an extraordinary ductility in single crystals. The mechanism of deformation has been examined in detail by means of X-rays. There is now a large body of evidence as to the directions of slip in a crystal during deformation, and this knowledge is essential to any understanding of the nature of cohesion, with which the chemical properties are no doubt closely connected.

We may now turn to the subject of chemical reactions which take place in the interior of a solid, either originating at the surface or from nuclei which make a spontaneous appearance in the course of cooling below the melting point. A chemical change which has begun at some point in or at the surface of a homogeneous crystalline mass cannot advance unless the atoms are able in some way to change their places. Gross movements, represented in gases and liquids by convection currents, are out of the question, but the slower process of diffusion, by which atoms or molecules can make their way through the solid, must be possible. Experiment shows that diffusion in solids, whilst naturally a slow process in comparison with diffusion in liquids, proceeds at quite measurable rates.

The classical example of such measurements, and for many years the only one, is the study of the diffusion of gold in solid lead, undertaken by Roberts-Austen in 1896. A much simpler example is that of silver and gold, two metals which resemble one another closely in chemical character and in atomic volume, so that diffusion causes less change of properties than in any pair of less closely similar metals. The experimental results prove, as might have been anticipated, that diffusion is a much slower process when there is so little difference in chemical character. When the two kinds of atoms are closely alike, the tendency to diffuse must be small, but it is certainly not zero. By making use of an ingenious device, Hevesy has been able to determine the coefficient of self-diffusion of liquid and solid lead. Two isotopes should not differ appreciably in their rates of diffusion, so that when the radioactive isotope thorium B is allowed to diffuse in ordinary lead, the experiment is equivalent to selecting a certain number of lead atoms and attaching labels to them by which they may be identified in the course of their journey. In this way he found that the diffusion in liquid lead near to the melting point was of the order of that of salt in water, but that in the solid state it was very small. Further experiments, using a thin foil, proved that at 2° below the melting point the rate was $1/10,000$ of that in molten lead.

When a liquid mixture of two substances which are miscible in the solid as well as in the molten condition, such as an alloy of copper and nickel or a fused mass of albite and anorthite, begins to solidify, the composition of the crystals has to adjust itself continuously in order to maintain equilibrium with the changing liquid phase, as was shown by Roozeboom in his classical work on solid solutions. Such an adjustment is only possible by means of diffusion, and when cooling is sufficiently slow, the adjustment does in fact keep pace with the change in the liquid, but with more rapid cooling the interior of each crystal differs in composition from its outer layers, there being a concentration

gradient from the centre to the boundary. This condition produces the "cored" crystals which are familiar to every metallurgist, and the "zoned" crystals of the mineralogist. In most alloys this want of homogeneity disappears after a sufficiently long period of heating at some temperature below that at which the first drops of liquid are formed, but alloys of bismuth and antimony fail to become uniform even after weeks of annealing, whilst the feldspars and similar minerals have never been persuaded to lose their zoned structure by any methods known in the laboratory.

Bruni has shown and Vegard has confirmed the observation by the X-ray method, that true interdiffusion occurs between potassium and sodium chlorides when mixed and heated in the solid state. Electrolytic transport is observed in the solid halides of silver and in mixtures of silver and copper sulphides, but the modern view of the structure of such substances represents them as built up of ions rather than of neutral atoms, and this must be taken into account in any interpretation of the facts. The apparent absence of diffusion in minerals which have once solidified, even when given geological periods of time, is a serious difficulty in the way of any general theory of diffusion. Such examples of the passage of alkali metals through quartz and other silicious minerals under the influence of a difference of electric potential are probably not examples of true diffusion at all, but merely of the passage of traces of impurities through a mass which is not completely impervious.

A new field of investigation has been opened up by Tammann in his attempts to determine the arrangement of the atoms in solid solutions by purely chemical means, by studying the action of chemical reagents on the solid. It is a familiar fact that the "parting" of silver and gold in assaying, which consists in dissolving out the silver from the alloy by means of nitric or sulphuric acid, is only possible when the silver forms more than 60 per cent. of the alloy. When gold is present in excess of this proportion, only a little silver is removed from the surface, and the action then comes to a standstill, the acid being unable to penetrate to the interior. Assuming the alloy to be completely crystalline, the atoms of silver and gold will occupy the points of the space lattice, and as the two metals have face-centred lattices of only slightly differing dimensions, the amount of distortion will be small. There are, however, different ways of arranging the two kinds of atoms. They may be distributed at random, or they may be so regularly arranged as to form two interpenetrating cubic lattices.

The two forms of distribution may be distinguished by means of the X-rays, but Tammann has also drawn conclusions on the point from the action of various reagents on the alloys. He finds that each reagent which attacks silver ceases to act on the alloys when the proportion of gold atoms in solution exceeds a certain limit, which is not the same for different reagents, but he states that it is always capable of being expressed as $1/8$, $2/8$, $3/8$, and so on, of the total number of atoms. The limits so found are not consistent with the distribution according to the laws of probability, but they may be accounted for by a regular distribution on the assumption that a certain number of inactive atoms is necessary to protect each atom of silver.

On the basis of these results, an ingenious theory of the action of reagents on solid solutions has been constructed, and although the accuracy of the experimentally determined limits is not high, and there are several exceptions to the rules, an interesting case has been made out.

If our knowledge of the chemical properties of the interior of a crystal be very incomplete, what are we to say of its surface? Of this we know still less. Even in a crystal of a pure metal there must be some difference in the structure at the immediate surface, on account of the unsymmetrical forces between the atoms in the outermost layer and its neighbours. For so far as the radius of sensible atomic forces extends, therefore, there must be a condition different from that which prevails at a depth below the surface. One consequence is that the surface has residual affinity, which shows itself in the ease with which foreign atoms or ions will attach themselves to it. That the forces acting are chemical is shown by the great effect on the extent of adsorption of the chemical character of the solid and of the adsorbed substance. Films, often one atom thick, attach themselves to the solid, and are only removed with the greatest difficulty. Their presence makes the investigation of the properties of a surface difficult, as the surface actually examined may be in reality quite different from that which is assumed to be present. In photochemical experiments with mercury it is usual to prepare a completely fresh surface of the liquid metal by causing it to flow continuously in a fountain, but this device cannot be applied to solids. Only rarely can experiments be made with perfectly defined solid surfaces. Films of metal prepared by sublimation or sputtering in a vacuum are probably the most under control, but other surfaces are commonly covered by invisible films.

Schumacher has recently shown that mercury wets glass and silica more and more readily as care is taken to remove films from them, and the property of not being wetted by mercury is probably not one of glass and silica, but of those substances coated with a film of gas. Metals most readily take up atoms of oxygen or other elements, forming persistent films, which play an important part in the phenomena of resistance to corrosion.

There is one way of preparing a fresh surface of a crystalline solid for examination, and that is by cleavage. A freshly cleaved plate of a mineral may be supposed to be clean at the moment of its formation, although it will rapidly take up foreign atoms from the surrounding gas. Tammann has made the interesting observation that a fresh surface of mica is more soluble in water than an older one. Washing with water immediately after cleaving extracts a quantity of alkali salts which is much above the normal solubility of mica, and later washings extract only the normal quantity. It is suggested that the separation of the flakes of mica exposes the alkaline part of the molecules, which would be more readily attacked by water than the silicious part. It will be interesting to see whether the X-ray examination of mica confirms this arrangement. Again, however, a word of warning as to the effect of possible impurities must be uttered. Natural minerals are not pure, and any uncombined alkaline salts present might well segregate along cleavage planes in the

process of crystallisation, and so give rise to the effect noticed above, but the figures recorded by Tamman are striking and suggestive.

In this hurried review of a large field it may seem that I have presented rather our ignorance than our knowledge, my intention having been to show how much remains to be done before we can understand the chemical relations of solids as we do those of liquids and gases. One department of research is, however, more advanced than might have been supposed from my brief references to it. That is the study of the internal changes in metallic alloys as revealed by the microscope and by thermal and electrical methods. Metallography has made wonderful progress since the days of Sorby, and it would repay students of physical chemistry to give some attention to its main results, even though they may not intend to make a special study of the subject. Nowhere are the benefits of the doctrine of phases of Willard Gibbs to be more clearly traced, whilst the recognition of every change of phase by microscopical examination, making use of a tech-

nique which has been brought to a high state of perfection, gives concrete reality to the study by direct verification of its conclusions.

To understand more thoroughly the mechanism of these changes in alloys and to extend its application to salts, minerals, and rocks, we need a fuller knowledge of the relation between crystal structure and chemical behaviour. Research on the mechanical side is discovering the direction of planes of slip in the atomic space lattice under stress, and it remains to determine the corresponding planes of greatest and least chemical activity towards a given reagent. Next follows the still unsolved query as to the nature of the inter-crystalline boundary, and the solution of these two problems will make it possible to define exactly the chemical character of a given aggregate of crystals. The results will be of extreme interest for the study of metallurgy, of mineralogy, and of petrology, besides filling a serious gap in chemistry, serious because of the extent to which solids compose the world around us, and of the part which they play in our daily life.

The Meaning of Wages.¹

By Miss LYNDIA GRIER.

IT is as little within my intention as it is within my power to put forward a theory of wages. My business is one of analysis, not of construction, of re-statement, not of creation. My purpose is twofold: first, to discuss certain aspects of wages, and then to review from those aspects certain payments made to or on behalf of employees.

Let us then consider three aspects of wages, each important in its way. First, there is the distributive or competitive aspect, from which wages are regarded as a factor determining where labour shall go, who shall command it, in what manner labour of certain types and given efficiency shall be employed. Competition between employers seeking the best workers is expressed in the wage they offer, and competition between workers seeking the best employer is expressed in the wage they accept. This competition tends to bring the wages of workers of equal efficiency to equality and to ensure that the wages of workers of unequal efficiency shall be unequal.

Taken alone, this idea of wages treats of the supply of labour as being fixed independently of the wage, and of the wage as powerful only in directing the available supply. It is therefore a short-period consideration, dealing with market price rather than normal value; as in all short-period considerations, stress is laid on the quantitative side, on the notion of value falling with an increase in the supply of labour and rising with a limitation of supply.

Secondly, there is the idea of wage payment which treats of work and wages as completely interdependent, since the product of each worker constitutes his payment. The product of each worker, represented by his wage, makes an effective demand for the produce of other workers. His addition to wealth is his claim upon it. Numbers are important only if with alteration in numbers there are consequent alterations in

productive power per head, or if the proportions between the different types of labour required be ill-adjusted.

Finally, we may take the aspect of wage payments which is concerned with their effect on work and on the supply of workers, the wage being regarded as something that maintains the worker.

These three aspects of wages are not antagonistic. It is clear from the outset that there is no contradiction between the first two, between that from which they are regarded as a distributive force and that from which they are regarded as the actual product of the wage-earner. The idea that the worker produces so much wealth and that his work is paid in proportion to the wealth he produces is, indeed, associated with the idea that the demand for and supply of such labour as he has to offer determines its value. Wages so determined are known as "fair" or "normal": fair in that they are equal to those of other workers of similar capacity, normal in that they are the wages that tend to be paid under conditions of free competition.

Each worker on this reckoning tends to get what his work is worth. It may be worth little. This admission does not apply only to bad workers. It certainly does apply to them, whether the badness of their work be due to bad character, bad health, or bad mental equipment. But the question is one not only of efficiency but also of the type of ability and of the number of other workers possessed of that particular type. Work which is not entirely unskilled may be ill-paid if the numbers competent to do it are great. This is, perhaps, especially the case with women's work.

For the most part, earnings are low in occupations that offer no special attractions and are filled by workers who, thanks to heredity, or sex, or environment, have little chance of entering others. The able man or woman has not only the fun of being clever, but also the advantage of high earnings through belonging to a grade in which the numbers are relatively small.

¹ From the presidential address delivered at Southampton on August 28 before Section F (Economic Science and Statistics) of the British Association.

It is, perhaps, unfortunate that wages which reflect the value of the work done should be known as fair wages. It has already been stated that they are known as fair because they are equal, if mobility is perfect and competition free, to those of other workers of equal capacity and doing work offering equal attractions. It is the equality that has led to the epithet "fair." But it is a not very convincing fairness to the man receiving a low wage whose work is worth little through no fault of his own. For when the demand price sufficient to absorb all the workers in a given grade is small or, in more technical language, when the marginal net productivity of such workers is low, when the workers in that grade are neither bad nor careless, other members of the community gain by cheap goods as the workers lose in low pay.

Plenty is generally an advantage to the community. We rejoice if land is plentiful in proportion to the population and rents are low. We should like capital to be plentiful and cheap, competing for employment at a low rate of interest. We are aware also that the owner of a limited supply of a commodity that becomes plentiful loses wealth as the consumer gains it. It is one of the anomalies of economic measurement that when a country becomes richer through an increased supply of certain goods, wealth as represented by those goods may be calculated as being less than before, because of the lowering of this exchange value.

The owner of anything other than labour may be compensated, or more than compensated, by the greater amount he possesses. Not so the worker. Each worker is lord only of his own labour. Recognition of this leads to limitation of output. There are, roughly, two ways in which men may increase their own wealth: by increasing or by decreasing production. Adult workers who have their youth and their training behind them have little power of doing the first, and fall back on the second. Through limiting output, erecting barriers against new-comers into their trades, they may successfully maintain or raise their own wages. From this point of view the objection of men to opening to women any new branch of industry is perfectly logical. If women be found capable of doing work formerly reserved for men, and are allowed to do it without let or hindrance, they will tend to have a depressing effect on the wage; not because of their sex, but because of their number. Their exclusion from many trades makes their entry to any single trade formidable; they are jealously excluded from one type of work because they are jealously excluded from others; thus they come to be considered natural blacklegs.

It is not profitable to pursue this subject further, however, without discussing the third aspect of wages, and considering not merely the wage that a man is worth but also the wage that he needs. Wages, in addition to directing labour and being a return of goods and services to labour in exchange for the goods and services it supplies, are expected to maintain the worker. The owner of labour alone among owners of any agent of production is supposed to live on the product of the thing he owns. The economic fact that to a great extent he does so has been exalted, like many other economic facts, into a moral obligation; and when the normal wage is low without any discernible fault on the part of those who earn it, the moral obliga-

tion is shifted and it is said that the wage ought to be large enough for the worker to live on.

It being assumed that the worker lives on his wage, we concern ourselves greatly with the question of how far wages do or can be made to respond to needs. We are challenged daily, by proposals for minimum wage rates, cost of living standards, family allowances, contributory insurance schemes, to consider the connexion between the normal wage and a wage adjusted to the needs of the worker. The question is a complicated one.

It is far easier to see the connexion between the wage and "training and sustaining" the worker's energy than between the wage and the cost of rearing the worker. If labour be not adequately sustained during the period for which the worker is engaged the product will suffer. Diminution in the number of workers available, or in efficiency, or both, follow swiftly on lack of sustenance. Further, the wage must bear some relation to the cost of training, since so long as there are occupations which demand no training, or less training than others, those needing most will lack recruits if the earnings they offer are not relatively high.

The cost of rearing the worker raises different questions. It is clear that the individual worker does not pay for his own childhood; no bill of the cost is presented to him when he begins to work. It is equally clear that the childhood of most wage-earners is paid for from wages; part, and a considerable part, of the wage of many workers is devoted to the maintenance of their children. It may be said crudely, therefore, that unless wages cover the cost of rearing workers, there will be no workers. It cannot, however, be asserted that because a worker pays certain expenses from his wages those expenses are the cause of his wage, or of any part of it.

There is a tendency to assume that, while the efficient sustenance of labour during working days and hours is a prime cost of industry to be covered by the wage, sustenance in non-working days and hours, in sickness, during unemployment, in old age, and the maintenance of wife and children not only during but also after a man's working life, is a kind of supplementary cost for which provision should be made in respect of work done. This presupposes a vast amount of calculation both on the side of the employer and the employee.

First let us take the employee, as being the party to any wage contract most likely to reckon such costs. Here, roughly, we find workers divided into the calculating and non-calculating classes, those who expect security and those who do not: an expectation which probably makes a far sharper class distinction than that made by riches and poverty.

Arrangements for contributory insurance schemes have long been common in the professions. Contributory insurance schemes for the provision of pensions have, with the exception of some of the less exalted branches of the Civil Service, in the past been made compulsory among those classes who before their introduction attempted to make similar provision voluntarily. The same classes have perhaps more than others calculated the number of children whom their earnings would maintain. The fertility statistics of the last census show that the professional classes, who are very largely the calculating classes, have a

lower fertility rate than any other occupied section of the community: 0.90 being the average number of children under sixteen for married men in the professional classes as compared with 1.27 among all married men. These classes who calculate the future are but a small section of the community.

For most earners the exigencies of present maintenance exclude considerations of future maintenance. With dependents the case is somewhat different; more and more every class of the community tends to consider the possibility of making good provision for its children, and more and more do the parents of every class recognise that they can provide for their own needs by limiting the size of their families.

The effect on earnings of calculations made by the worker, either for his own future and that of his dependents or for the present needs of his dependents, is not easy to trace. A stimulus to activity which in effect raises the wage-earner to a higher grade, increasing his productivity and general wealth, makes him worth a higher wage. A limitation of numbers is slow in its action on supply, and, since it cannot be assumed that each grade or occupation is entirely self-recruiting, no positive result can be ascribed to it, except in so far as it is thought that a general increase or decrease of population is likely to cause a general rise or fall in wages.

Let us now turn to the question of how far such calculations affect the employer, purely from the business point of view. Employers have not reckoned the whole of the worker's life or maintenance of his dependents as an overhead charge. They do not pay adult male employees at a high rate because they have families dependent on them or because they must make provision for the future, but because their productivity is relatively high and because they are strong and experienced workers. They do not gravely reckon the average family of an average worker: they reckon what the man's work is worth.

Nor do the needs of the worker provide him directly with additional bargaining power. It has generally been recognised in foreign trade that needs are a weakness and not a strength in bargaining. It is the same with the worker. So far as fighting strength goes, bachelors who are without dependents can fight more effectively than men with families. The mere acquisition of a new set of needs, unless it stimulates activities and so is part of a higher standard of life, adds to misery and not to wages. To a certain extent it is notorious that dependents do stimulate activity, married workers being generally steadier and more regular than unmarried ones. Their higher productivity raises their earnings. But it is to be feared that bargaining power is in no way enhanced by the number of dependents, and every one present will call to mind cases of men who dare run no risk of losing their job because of their wives and children.

In view of this, we may think it fortunate that the workers who get low wages so often have few needs. Young untrained workers whose productivity is low have no dependents. They have often, in fact, just ceased from being dependents themselves and become contributors to the family wage. If women are crowded into a somewhat small number of occupations with low rates of pay, it is some comfort to remember that they

have comparatively few dependents to suffer from those low rates.

If we agree that the normal wage in some cases rises above and in many falls below the wage required by the worker for his maintenance in the future as well as the present, and for the maintenance of his wife and family in both the present and future, what should be our attitude towards the many persons and bodies who are concerned with raising the wage rate, with charging provision for unemployment and the future on to wages, and with readjusting wage rates? It is clear that we cannot expect the approximation of normal wages to wages adequate for such maintenance to be the main preoccupation of social reformers or statesmen.

Measures concerned with wages may be put into three categories roughly coinciding with the three aspects of wages with which we began. First, there are those which are concerned with the mobility of labour, with seeing that labour is as swiftly as possible directed where it is most needed, by the dissemination of knowledge, by facilities for movement such as are offered by the employment exchanges, by vocational selection, by the efforts of trade unions to ensure that in every instance the rate received shall be at least the normal rate. Secondly, there are those which attempt to increase the productivity of the worker and raise him from one grade to another; such as measures of educational reform, improved social conditions, even, when wages are very low, minimum wage rates, which by improving the health of the worker increase his productive capacity. Thirdly, there are measures which attempt something further and try either to add to the normal wage rate or to "stretch" the rate so that it will pay for things that it did not previously pay for.

I do not propose to discuss the first two categories; their value is obvious. We are being forced, however, increasingly to discuss the third category. It includes schemes for fixing such minimum wage rates as do not increase productivity; cost of living standards when they attempt something other than the maintenance of the normal wage; schemes for subsidising certain sections of wage-earners, such as systems of family allowances; and schemes for stretching normal wages to cover certain costs, such as compulsory insurance schemes.

Where these schemes ensure a given rate of wages their advocates desire that it should be secured without unemployment ensuing. Where, as in compulsory and contributory insurance schemes, a charge is levied on employer and employed, it is presumably not desired that unemployment benefit should be provided by measures which, by making labour costs high, increase unemployment, or that hypothetical widows and fatherless children should be provided for by schemes which, by reducing wages, stint actual wives and the children whose fathers are living.

Minimum wage rates may be maintained without unemployment following when, as has already been suggested, through their reaction on efficiency they increase the value of the work done, and also where the demand for the labour employed is inelastic. Trade boards have proved this. It may further be argued that, when normal wages are too low to provide adequate maintenance for all workers belonging to a given grade,

it is better to enforce a wage adequate for the maintenance of a certain number, and, having so produced a certain amount of unemployment and defined the problem, take steps to deal with the unemployment.

When the question is one not of the minimum needed for efficient sustenance but of the relative rates in different occupations, according to the degree of skill required and the customary rates for work of a given kind, the problem becomes different, as in the case of cost of living standards. There is nothing sacred about relative wage rates; they are exceedingly arbitrary as between different occupations and between different types of skill in the same occupation. Wage rates normal in the past are not normal in the present and will not be normal in the future. They are subject to infinite variations. The balance is mobile and cannot be stereotyped. It is a pointed commentary on this fact that the Cave Committee reporting on the Trade Board Acts in 1922 advised that the boards should in future confine their activities to the settlement of wages when such wages are unduly low and no other adequate machinery exists for their effective regulation.

This report and consequent legislation marked the abandonment of one attempt to legislate on relative wage rates. But if one attempt was abandoned, others remain. The minimum wage rate in the coal-mining industry is being hotly discussed, and, apart from legislative enactments, cost of living standards as a basis not for wages but for fluctuations in nominal wages are commonly enforced by trade union action. A wage which is "above the normal" is in effect a subsidy given to the worker in respect of a particular type of work. In a sense, nomenclature matters little. We tend to call anything a wage which is given by an employer to a worker, and to call anything a subsidy which is given to a worker or an industry or any one or anything else by the State, and to dub as taxes revenue collected by the State. But when we analyse payments above or below normal wages, we find that we are generally tracing their incidence and dealing with transferences of wealth rather than with costs. Sir Alfred Mond's scheme is frankly a subsidy. Nor is there in effect much disguise about the "tax and subsidy" nature of the family allowance system. Bachelors are to be taxed, or to tax themselves, for the sake of men who have families. It is recognised that it is on the whole unwise to put the administration of the "tax and subsidy" in the hands of the employer, lest he should mistake a tax and subsidy scheme for a new wage system under which it would be greatly to his advantage to employ bachelors instead of married men. Once it is frankly admitted that large families neither force nor enable employers to pay high wages, we can if we wish settle down to a discussion of the ethical and economic advantages of family endowment; and we can contrast the advantages of making provision for families within each industry separately or through a more general scheme of taxation.

From the suggestion to tax certain wage-earners for the benefit of other wage-earners we may pass to the practice of taxing wage-earners for their own benefit, as embodied in unemployment and health insurance schemes, in the various pension schemes already adopted in the Civil Service, and as proposed in the Pensions Bill. It may be said that here we are not

dealing with taxation but merely with deferred pay; that the contributions, covering as they do the workers' own risks, are a forcible method of saving, but cannot fairly be called taxation. This is perfectly true when the saving would or could be made voluntarily. But when wage-earners are too poor to save, enforced saving leaves them for the time being poorer than before, and Mr. Neville Chamberlain's hope that the Pensions Bill "would encourage people to try to add to the benefits and thus achieve complete independence for themselves" is likely to be frustrated by the reduction in their means. We are agreed that the benefits of these schemes must be secured. We are, I believe, agreed that they must be augmented. But the provision of future benefits by taxes on present wages may not be the best method of giving such benefits when wages are low. The wage may be too small to be deferred. Nor does the fact that employers pay a larger proportion when the wage is exceedingly low help those who are on the verge of unemployment and may by this arrangement be pushed over it.

It is to be feared that if normal wages be not adequate to cover calculations for the future, contributory schemes, however advantageous, may make things more difficult than before for workers belonging to a grade in which numbers are great in proportion to demand. It cannot be assumed that the demand for such labour is inelastic. In many instances it is, as when labour paid at a low rate is employed in co-operation with better-paid labour and in industries in which its cost is but a small proportion of total cost. But frequently the demand is elastic, as in agriculture, where we are constantly told that labour cannot profitably be employed even at minimum wage rates which seem to many of us less than moderate.

Contributory insurance schemes have occupied much attention lately, probably more than they deserve. The contributions demanded by each individual scheme are no great matter; even taken together they do not amount to a vast charge per worker. But, small as they are, they are of interest as being attempts to stretch the normal wage to meet the needs of maintenance when, in terms of that wage, the worker is not always worth a rate which will enable him to meet all the demands made upon him for his own immediate support and that of his family.

The normal wage is defiantly rigid. It is also brutally erratic. It will not be stretched to meet any but the most immediate needs of workers in low grades; it is capable in times of depression of falling below even that low standard. In the process of asserting itself it drives men ruthlessly from occupations for the products of which demand has fallen. The secret of its mastery lies in the fact that it offers the one price at which all labour of any given grade can be absorbed in the occupations to which it is admitted. Whatever be the rights of the coal dispute, it is true that a point may come at which any industry or any single firm in an industry may be unable to pay a living wage to all those occupied in it. The normal wage commonly offered in other occupations for the same grade of labour will only be given in such an industry when enough men have left it to make the rate even throughout the grade. In the meantime labour may suffer greatly, and the productive power of all industry may suffer, since nothing is

so destructive to a man's capacity or more likely to force him into a lower scale of labour than a prolonged spell of unemployment.

There are those who hope that in time the normal wage may in all ranks of labour be at least adequate to maintain workers and their families through all uncertainties and vicissitudes. They believe that the progress of invention will immensely increase productivity; that improved business methods on one side and rising standards of work on the other will make each worker more productive; that ultimately education will raise all workers to the ranks of those whose work is worth much. But until that Utopia arrives it is well to recognise that, except by making wages abnormal, we cannot at present expect them in all cases to do what is required of them.

It is blindness to pretend that the normal wage must necessarily provide for all needs, or that the worker is necessarily to blame if it does not. Those more fortunately placed among the workers, as well as among other classes of the community, often gain by the cheapness of the goods made by workers whose work is worth little because their numbers are great. But the community as a whole does not gain, because the workers receiving low wages are part of the community.

It is roughly true that the normal wage distributes labour well through distributing wealth ill. Redistribution of wealth is therefore necessary. Redistribution in the name of wages tends to interfere with the distribution of labour; for this reason it might be well to leave wages to mean normal wages and to redistribute wealth by other methods.

Obituary.

SIR WILLIAM SCHLICH, K.C.I.E., F.R.S.

THE death of Sir William Schlich, who succumbed to an attack of bronchitis on September 27, at eighty-five years of age, removes from the world of forestry one of its outstanding figures of the past half-century. A native of Hesse-Darmstadt, Schlich studied at the University of Giessen, taking his degree of Ph.D. in 1866. The same year he was offered and accepted a post in the Indian Forest Department, then in its infancy, and was posted to Burma, where he served as deputy conservator of forests until 1870, when he was transferred to Sind, where he remained for two years. In 1872 he was promoted to the conservatorship of Bengal, which in those days comprised the present provinces of Bengal, Assam, and Behar and Orissa. For seven years he threw himself with energy and conspicuous success into the arduous work of organising forest operations in this huge tract. After a spell of leave to Europe, followed by a short period of service as conservator of forests in the Punjab, he was appointed towards the end of 1881 to act as inspector-general of forests to the Government of India: he was confirmed in this appointment in 1883, when his predecessor, Dr. Brandis, retired from the service, and held it until 1885, when he proceeded to England to take up the post of professor of forestry in the newly created forestry branch at the Royal Indian Engineering College at Coopers Hill.

During Schlich's period of service in India, the work to be done consisted largely of preliminary organisation, and the conditions were by no means easy. In the earlier years the superior staff consisted for the most part of men without any scientific training in forestry, although by the time he left India matters had improved vastly, owing to the steady flow of British recruits trained at the Nancy Forest School in France, and to a smaller extent in Germany. These earlier years of the forest department were marked by strong opposition, not only from the timber trade and other interested parties, but also from Civil officials, many of whom regarded the conservation and national management of the forests as an uncalled-for innovation. Perhaps the most important advance which marked Schlich's term as head of the department was the creation of a special working plans branch in the office of the inspector-general of forests; this provided for the expert

scrutiny of all forest working plans before they received final sanction, thus ensuring their preparation on correct lines.

So far as his work and activities were concerned, Schlich's appointment in 1885 to the professorship of forestry at Coopers Hill marked the beginning of a new era. From that year onwards he was destined to devote himself to the teaching of forestry, and it is in this sphere of activity that he was best known to the present generation. Combining sound knowledge and judgment with an enthusiasm for his subject which was infectious, and possessing a keen sense of humour and a remarkable capacity for winning the confidence and affection of his pupils, he was the embodiment of those qualities which go to make the ideal teacher. What the British Empire owes to him may be realised from the fact that his old pupils are to be found throughout its length and breadth. Immediately prior to the War, some ninety-five per cent. of the Indian Forest Service, from the inspector-general to the latest joined assistant conservator, were old pupils of his, while at the present time there is not a single senior officer of that service who was not trained by him.

Schlich became a naturalised British subject while at Coopers Hill. His educational duties there covered a period of twenty years, during which time he was responsible primarily for the training of recruits for the Indian Forest Service, although a few forestry students of the College obtained appointments in other parts of the Empire. On the abolition of Coopers Hill in 1905, its forestry branch was transferred to Oxford. Here Schlich, although sixty-five years of age, threw himself energetically into the work of organising the school of forestry in its new home and making it worthy of the great University which had adopted it. Through the generosity of St. John's College, aided by other benefactors, a building was erected with lecture rooms and a museum. In 1911 Schlich severed his official connexion with the India Office when he retired under the Civil Service rules; he was thereupon appointed reader and, by decree of Convocation, given the status of professor of forestry. By this time the Oxford school of forestry had fully established its reputation, and had become responsible for the training of numbers of forestry students destined not only for the Indian service, but also for many other parts of the empire. Schlich's

chief ambition while at Oxford was to bring forestry into line with the other main scientific departments of the University and to obtain for it that recognition which its growing importance deserved. He therefore set to work to collect funds for the endowment of a permanent chair of forestry, and his appeal met with a sympathetic response from various sources, both official and private. He had the satisfaction, not long after the conclusion of the War, of seeing the realisation of his dreams, for a permanent professorship of forestry was constituted in 1919, and in the same year a statute was passed placing forestry among the degree subjects until then it had ranked as a diploma subject only. He finally laid down the reins of office on January 1, 1920 when he was succeeded by one of his old pupils.

Schlich was an honorary fellow of St. John's College, Oxford. He was elected a fellow of the Royal Society in 1901, and was created K.C.I.E. in 1909. His best-known work is his "Manual of Forestry," in five volumes, of which three were written by himself and two by his former colleague, the late W. R. Fisher. Among his other publications may be mentioned "Afforestation in Great Britain and Ireland," "Forestry in the United Kingdom," and a large number of papers, reports, and other writings. He was a member of the Forestry Sub-Committee of the Reconstruction Committee which was appointed in 1916 and issued its final report in 1918. He held the office of president of the Royal English Arboricultural Society in 1913-14, and was on the governing council of the Empire Forestry Association at the time of his death. In spite of his advanced age, he retained his mental vigour unimpaired until the end, and worked hard at the revision of his "Manual of Forestry" after retiring from his post at Oxford; he brought out new editions of vol. 1 in 1922 and vol. 3 in 1925. He was married twice, and is survived by a widow, a son, and four daughters.

R. S. TROUP.

✓ PROF. ANDREW GRAY, F.R.S.

THE many old students of emeritus Professor Andrew Gray, some of whom are scattered all over the world, will be sorry to hear of his death. His strong personality, ability as a teacher, and unwearying patience in explaining difficulties, must have endeared his memory to many thousands of students. There are few men who worked harder or have left a greater record of work. His life was a full and a happy one, and his sympathy with the early struggles of young men considerably lightened his onerous duties as a professor. He belonged to the diminishing band of mathematical physicists, and he once told the present writer that what he called the "Laodicean" attitude of many scientists towards mathematical physics was seriously discouraging research in this direction. In a letter some years ago, written when revising his "Absolute Measurements," he complained of feeling tired, but added that he must finish his work for *ἐρχεται νύξ*. The night has now come, and he sleeps well who toiled during many years to advance our knowledge of Nature.

Born in 1847 at Lochgelly, in Fifeshire, Gray began his mathematical studies in the subscription school at the time of the Indian Mutiny. His text-book was "Practical Mathematics," by John Davidson. Modern

educationists might consider the book a collection of mathematical scraps, but Gray often spoke of the intense interest it excited in the boys. By means of a measured base line, 10,110 feet long; they could measure the distance of Nelson's monument on the Calton Hill at Edinburgh, the lighthouse on the island of Inchkeith, the Martello Tower at Leith Harbour, North Berwick Law, and so on. The solutions of such problems had an interest that no mere diagrams with their letters A, B, C . . . could ever give.

At the University of Glasgow, Gray studied very hard and gained many honours. He once told the writer the reason why he did not obtain more. On one or two occasions he had to leave a fortnight before the end of the term in order to assist in farming operations at home. On one occasion this probably lost him the gold medal which is given to the best student in the senior Greek class. He ever put duty before personal ambition. He graduated as M.A. with honours in mathematics and natural philosophy. Gray was an excellent classical scholar, and in his later years he derived much pleasure from reading Latin and Greek poetry. Like his friend Prof. Chrystal, he was a great admirer of Schiller's poems and knew many of them by heart. His Greek testament was his constant companion.

Gray was private secretary and assistant to Sir William Thomson (Lord Kelvin) from 1875 until 1880; and official assistant to him from 1880 until 1884. About this time electric lighting was gradually coming into use, and electrical measurements became of practical importance. Gray wrote a series of elementary papers on the subject for NATURE, which attracted considerable attention. They formed the nucleus of his treatise on "Absolute Measurements in Electricity and Magnetism."

To be an assistant to Lord Kelvin was not an easy post. Having many interests which took him away from home, his assistant could never tell before the lecture what aspect of the subject the professor was going to discuss or what apparatus he would want. He kept all his staff busy with his work and their individuality was apt to be submerged. In 1883 Gray published the first volume of "Absolute Measurements," which has been a great help to many. Kelvin told him that he ought not to have published it so long as he was his assistant. Nowadays this would be an impossible attitude for a professor to take up. No one, however, had a higher opinion of Kelvin's abilities than Gray, or more revered his memory.

In 1884 Gray was appointed to the chair of physics in the newly founded University College of North Wales. Amongst his new colleagues were Henry Jones, the distinguished philosopher, James J. Dobbie, later the principal of the Government Laboratory, and George Ballard Mathews, a mathematician possessed of rare gifts, with whom he co-operated in writing the well-known "Treatise on Bessel Functions." While in Wales he took the leading part in the foundation of the County School for Girls in Bangor, and championed the cause of the higher education of women. At this time he was also an enthusiastic mountaineer, and made weekly excursions with some of his colleagues into the Welsh hills.

On the death of Lord Kelvin in 1907, Gray was

installed as his successor to the Glasgow professorship. He delivered the University Oration in memory of Kelvin. This he later expanded in his book called "The Scientific Work of Lord Kelvin." In this book he gives an excellent account of the life and manifold activities of his famous predecessor.

Gray planned the present Natural Philosophy Institute of the University of Glasgow, a task which absorbed all his energies for several years. The Institute was opened eighteen years ago by the King and Queen, then Prince and Princess of Wales. He also took a leading part in arranging for the comfort of the students, a subject barely considered by the professors of fifty years ago.

Of Gray's literary work we can only mention his "Treatise on Magnetism and Electricity" (1898), "Dynamics, and Properties of Matter" (1901), which was translated into German by Prof. Auerbach, "A Treatise on Dynamics" (1911), in conjunction with his son, Dr. J. G. Gray, and "Gyrostatics and Rotational Motion" (1919). This last treatise stands as a monument to the vigour and industry of the author, and also to his thorough understanding of the fundamental principles. In 1921 he published a revised edition of his "Absolute Measurements." The work was practically rewritten and involved an immense amount of labour. The early edition was found to be a great help by those who determined our electrical standards at the National Physical Laboratory. The late Dr. Rosa also, of the U.S. Bureau of Standards, Washington, much appreciated his formulæ and constructed an electro-dynamometer to Gray's instructions, which was found most useful.

Gray communicated many papers and gave several lectures before learned societies. In particular, the writer remembers the sixth Kelvin lecture he gave to the Institution of Electrical Engineers. He showed the gyrostatic apparatus Kelvin used in his lectures, and explained clearly the dynamical principles which they illustrated. He also obtained complete solutions of, and generalised, some of Kelvin's theorems. In his opinion, the teaching of dynamics and gyrostatics was badly neglected in nearly every university, and in many cases the old Newtonian philosophy had become a byword. Young mathematicians and physicists revelled in discussing relativity and quanta: the former possibly leading to higher orders of relativity and the latter to fruitless metaphysics. He did not mind these metaphysical discussions, provided the speakers had a sound knowledge of rotational dynamics, but he was afraid that few of them had.

Prof. Gray was very happy in his home life. He is survived by his widow, three sons, and four daughters. There was an interesting family gathering when he and his wife celebrated their golden wedding five years ago. He was glad when his second son James gave up engineering and followed in his footsteps; a decision which has since been justified by the excellent work he has done in gyrostatics and his appointment as professor of applied physics in the University of Glasgow. His two youngest daughters are well known in musical circles in Glasgow.

Gray was a strong swimmer, and when he was at Bangor he rarely missed his morning bathe in the Menai Straits. In his later years he loved to spend his

vacations in the Perthshire Highlands, where golden eagles are still to be seen holding their own in the struggle for existence. He always stood with deep reverence before the great problems of the soul and the destiny of man. •What he said of Kelvin we can also say of him: "He believed that Nature, which he had sought all his life to know and understand, showed everywhere the handiwork of an infinite and beneficent intelligence, and he had faith that in the end all that appeared dark and perplexing would stand forth in fulness of light."

ALEXANDER RUSSELL.

DR. CHARLES F. SONNTAG.

By the sudden death of Dr. Sonntag on October 10—only two days before the thirty-eighth anniversary of his birth—the Zoological Society of London has lost a Prosector who by temperament and enthusiasm for patient anatomical investigation had ideal qualifications for this office. At University College, where since 1922 he had acted as a part-time demonstrator of anatomy, Sonntag endeared himself to students and colleagues by loyal service and geniality, and to a wider circle by the lucidity and interest of his public lectures on the evolution of man.

Dr. Sonntag was born in Glasgow, his father being a naturalised Swiss and his mother Scottish. He was educated in the University of Edinburgh, where he took the M.D. degree with honours in 1912. After a varied experience of hospital work he received a Commission in the Royal Army Medical Corps when War broke out. On active service at Salonika he had the misfortune to contract phthisis and was invalided home. When convalescent he resumed work at the Red Cross Clinic in London and afterwards (1917–1919) in the Special Military Orthopædic Hospital at Shepherd's Bush. There he attracted the attention of Prof. Wood Jones, who recommended him to apply for the vacant prosectorship of the Zoological Society.

Although Sonntag had been interested in zoology from boyhood and had attained distinction in anatomy as a medical student, he really began his serious apprenticeship to anatomical research in 1919, when he was elected to the prosectorship. The distinctive quality of his service to the Zoological Society and University College has been aptly described in the *Times* of October 12 in these words: "Sonntag was an indefatigable worker, apparently with no interest in life except dissection and the encouragement of other dissectors." In spite of his ill-health and physical weakness his intense enthusiasm sustained him during the brief six years of his career as an anatomist, which produced an enormous output of original observations in the Proceedings of the Zoological Society. For four years he contented himself with recording facts, apparently without any definite aim in view. But the discipline of preparing (in 1923) his book on "The Morphology and Evolution of the Apes and Man" seems to have shaped his purpose. In 1924 and 1925 he marshalled the evidence he had been accumulating since 1919 on the comparative anatomy of the tongue; and at the summer meeting of the Anatomical Society last July he gave a masterly exposition of his investigations, carefully building up his argument that certain easily observed features of the tongue could be used as trust-

worthy criteria of affinity in the Primates and other mammals and as tests of the presence or absence of specialisation. The skill and insight displayed in this discussion of the fundamental principles of mammalian evolution revealed the fact that Sonntag had suddenly attained the maturity of his powers. Hence the magnitude of the loss his death inflicts upon the science of anatomy is more readily appreciated.

WE regret to announce the following deaths:

Mr. J. Y. Buchanan, F.R.S., chemist and physicist to the *Challenger* Expedition and Vice-Président du Conseil de Perfectionnement de l'Institut océanographique de Paris, on October 16, aged eighty-one years.

Prof. E. D. Campbell, professor of chemical engineering and analytical chemistry in the University of Michigan, distinguished for his work on the constitution of steels and hydraulic cements, on September 16, aged sixty-two years.

Mr. J. S. Gamble, F.R.S., lately Conservator of Forests in India and Director of the Imperial Forest School, Dehra Dun, on October 16, aged seventy-eight years.

Prof. H. Maxwell-Lefroy, professor of entomology in the Imperial College of Science and Technology, South Kensington, on October 15, aged forty-eight years.

Prof. H. C. Lord, professor of astronomy since 1900 at the Ohio State University, who made contributions to our knowledge of stellar motion in the line of sight, on September 15, aged fifty-nine years.

Mr. A. R. McCulloch, curator of fishes in the Australian Museum at Sydney and chief fishery expert of Australia, on September 6, aged seventy years.

Prof. Urban Pritchard, emeritus professor of aural surgery at King's College, London, president in 1899 of the sixth International Congress of Otolaryngology, and author of a "Handbook of Diseases of the Ear" and of papers on the structure and function of the cochlea, on October 16, aged eighty years.

Current Topics and Events.

THE Right Hon. Sir Horace Curzon Plunkett, F.R.S., sometime vice-president of the Department of Agriculture and Technical Instruction for Ireland, enters on his seventy-second year on October 24. A member of one of the oldest pre-Cromwellian Anglo-Irish families, he was educated at Eton and University College, Oxford. Soon after attaining his majority he took up (and very successfully) the development of a ranch in Montana, gaining a mass of practical knowledge and full acquaintance with American agricultural methods. He returned to Ireland in 1889, and thereupon engaged in propaganda work embodying the need for economic legislation which might revive and encourage individual enterprise and promote practical rural education. The ultimate outcome was the establishment of a Department of Agriculture. From time to time Sir Horace met with much criticism and opposition from parliamentarians of the day, his ideals of a new civilisation in Ireland not being, apparently, consonant with their political vision. Nevertheless he can look back to many notable accomplishments. Sir Horace is an Hon. D.C.L. (Oxon.) and Hon. LL.D. (Dubl.).

SIR FREDERIC L. NATHAN, the new president of the Institution of Chemical Engineers, an authority in the chemistry of explosives, was born on February 10, 1861. Educated professionally at the Royal Military Academy, he entered the Royal Artillery in 1879. For the period 1888-1892 he was second assistant to the Director-General of Ordnance Factories, and afterwards became Superintendent of the Royal Gunpowder Factory, Waltham Abbey; later he went to Nobel Explosives Company's Ardeer Factory as works manager. He was attached to the Ministry of Munitions during the War. Sir Frederic had as a brother the late Sir Robert Nathan, distinguished for his War services in secret service work. In 1909 Sir Frederic Nathan delivered an evening lecture at the Royal Institution on "Improvements in Production and Application of Guncotton and Nitroglycerine."

PROF. J. P. POSTGATE, writing on "Our Classics To-day" in the October issue of the *Fortnightly Review*, expresses satisfaction that the position of the classics has greatly improved during the past twenty years; and he traces the improvement largely to the activities of the Classical Association, which now comprises 2300 members and possesses a dozen branches. During the War, he says, it seemed as if the fanatics of modern materialism must carry the day; but the report of the Government Committee on "The Classics in Education" gave welcome proof to the contrary. He adduces evidence of the revival of ancient learning, and is gratified that a committee of the British Association did not fail to consider the claims of Latin to be chosen as the international auxiliary language, though he omits to add that the committee unanimously rejected the claims. For our part, we also rejoice that modern materialism has not carried the day. Like the antagonism between religion and science, that between humanistic and scientific learning has lost much of its old venom, for we realise that truth has more than one aspect, and that the desire for perfection may be stimulated in more ways than one.

In the past the autocracy of the classics was kept alive mainly by the force of tradition and the conservative instincts of our ruling classes; to-day classical learning is tending to rank side by side with natural knowledge as a master-key to the knowledge of man and as a superb implement for promoting accuracy of word and thought. Prof. Postgate views with approval the growth of literature designed for those who, not knowing Latin or Greek, yet desire to know about them; but he maintains that experiences recorded, thoughts intended, and speech employed constitute an indivisible trinity, and only through the last can the first two be reached. He laments the lack of Greek and Latin etymological dictionaries in English, condemns wholesale our school Latin dictionaries, and criticises the accentuation of Greek

and the want of appreciation of classical metre in our schools of to-day. Another object of criticism is the excessive cost of books for classical education, for which the intermediaries—the printer, book-binder, and book-vendor—are held to be responsible.

CONSIDERABLE interest has been aroused by the reports which have appeared of the performance of a novel type of flying-machine known as the Cierva autogiro. Test flights were made with the machine at Farnborough on October 19 by Capt. F. T. Courtney before representatives of the Air Ministry and a number of men of science and air-craft designers. The machine, which is the invention of Don J. de la Cierva, consists of an Avro fuselage with the wings removed, their functions being supplied by a four-winged windmill revolving freely on a central upright pillar. The four narrow wings, about 17 ft. in span, are pulled round by means of a wire in spinning-top fashion so that they revolve at about 120 revolutions per minute, and afterwards the forward speed of the machine keeps them moving at sufficient speed to give the lift required to maintain the machine in the air. The wings are articulated to allow them to rise and fall while the "windmill" is turning. Elevators and rudder are used as normally for control purposes. Capt. Courtney demonstrated that it is possible to land safely at a very steep angle, there being no need of great forward momentum as in other types of heavier-than-air machines. Descending at an angle of about 60° with the horizontal, the machine stopped in about two yards, while, when making a more normal descent, the machine came to rest within its own length. Another great advantage claimed is that, in the event of engine failure, the machine sinks downward and forward under the control of the elevators, and can be landed with safety.

THE September issue of the *Journal of Scientific Instruments* contains the address of Mr. F. Twyman, president of the British Optical Instrument Manufacturers Association, to the Association in July last. It deals with the present position of the optical industry in Britain, and it is most encouraging to find that, notwithstanding the small amount of business which is being done, the improvements in quality of the instruments produced in the last decade has been very great. The varieties of optical glass now available exceed 80 as against 26, and three British firms produce them as against one ten years ago. The work of the Research Association has given the industry a new and better abrasive, and has greatly improved the methods of colouring glass. The National Physical Laboratory has done work of a fundamental character on the theory of lenses and has turned out diffraction gratings of good quality. Microscopes, cameras, and telescopes have all been improved to a point which no foreign competitor has reached, and the testing of optical surfaces has been refined to such an extent that surfaces correct to one-millionth of an inch are obtained. An industry which shows so much vitality is bound to come through the present depression with its reputation enhanced.

IN addition to his many previous contributions to the science of spectroscopy, Prof. Kayser has now compiled a book of tables intended to lessen the labours of the ever-increasing number of workers in this field. Published by S. Hirzel of Leipzig under the title "*Tabelle der Schwingungszahlen*," the tables give the wave-numbers for wave-lengths between 2000 Å.U. and 10,000 Å.U. The wave-lengths have first been reduced to vacuum and then the reciprocals calculated. In the region 2000 Å.U. to 7000 Å.U. the wave-numbers are tabulated, to eight significant figures, for every 0.1 Å.U., while convenient interpolation tables on each page enable the reading to be made for every 0.001 Å.U. Between 7000 Å.U. and 10,000 Å.U. the entries in the table correspond to each Ångström unit. In addition, the value of $n - 1$, where n is the refractive index of air for the wave-length in question, is given for every unit, and also that of $\lambda(n - 1)$, so that the wave-length *in vacuo* can be readily obtained. In view of the great importance of optical frequencies and frequency differences to the theory of atomic structure, an immense amount of work is being devoted to the theory of spectra; up till the present, owing to the lack of tables such as these, this work has involved a great deal of laborious calculation. Much of the time spent in this way will, in the future, be saved by the use of these tables.

MIDDLEMEN'S profits and the level of retail prices have recently become important subjects of discussion. The public feels that the gap between wholesale and retail prices is too great, and this impression has been strengthened by the evidence brought forward by the Food Council. Systematic study of the facts is essential since the economic problems involved are of considerable complexity. In the *Economic Journal* for September 1925, Mr. W. R. Dunlop essays such an investigation of "London's Retail Meat Trade." He states that in London the weekly consumption of butcher's meat is 2.41 lb. per capita. Retailers are in a strong position because both the demand and the supply are fairly constant, but in practice he considers that competition is preventing abuse of this power. It might, however, be objected that tacit agreement among the retailers may serve to keep prices higher than they need be. Mr. Dunlop directs attention to the State-owned butchers' shops in Queensland. There meat is sold at 1d. to 2d. per lb. cheaper than in the private shops and the average net profit has been 0.2d. per lb., while on turnover the profit is 4.05 per cent. as against say 0.75d. per lb. and 6 per cent. in London. He points out, however, that it is not safe to argue from this that municipal shops would give satisfaction in London. Difficulties would probably arise from temporary shortage of supplies and also during the Saturday "rush hours," since London shops are much busier than those of Queensland. Moreover, Queensland produces all its own meat and exports a surplus.

THE history of the dyestuffs industry in Great Britain affords an excellent example of the precept that it is not enough to practise patriotism in time

of war: by the exercise of judgement and foresight during peace, we must seek to stave off the evil day and to prepare for any possible emergency. Organic chemists and plant for making organic chemicals are every whit as important as the production of dyed fabrics to deck our persons and our surroundings; and it is therefore a matter of national importance to keep the electorate aware of the vital nature of such so-called key industries. The Worshipful Company of Dyers is one of several City companies that has given practical recognition to these truths, its latest effort in this direction is the organisation of a series of lectures on dyestuffs to be given in London during the coming winter. The course of lectures is as follows. October 22, Sir Max Muspratt: How Dyes are made, November 19, Dr. E. F. Ehrhardt: The Patent Law as it affects the Dye-making and Dye-using Industries; December 14, Prof. G. T. Morgan: Recent Researches on Mordant Dyes, January 11, Mr. C. M. Whittaker: Artificial Silk Dyeing; February 15, Mr. R. F. Thomson: Vat Dyes and some recent Developments, March 25, Dr. H. Levinstein: The Dyestuff Industry and the State. Tickets may be obtained free of charge from the Clerk, Dyers' Hall, Dowgate Hill, London, E.C. 4.

MEMBERS of the British Association who took part in the Canadian visit, and who wish to be reminded in pleasant fashion of the delightful and varied vegetation of that vast dominion, cannot do better than read the entertaining article contributed to the Journal of the Royal Horticultural Society, Vol. 50, Part 2, by the Lady Byng of Vimy, under the title "Some of Canada's Wild Flowers." Whilst revealing the characteristic personality of the writer, and so written as to appeal to the non-botanist with an interest in flowers, this article gives an excellent account of the main type of vegetation met with in the trans-continental journey undertaken by the British Association, whilst the vivid phraseology conjures up charming pictures of Canadian scenery which for many of the British visitors must now remain in the mind as the background of a very pleasant "busman's holiday."

At the fifth Congress of Industrial Chemistry, organised by the French Society of Chemical Industry, and recently held in Paris, a Chevreul medal was awarded to Prof. Henry E. Armstrong, and Sir Robert Hadfield, Bart., was elected an honorary member of the Society.

THE Baly Medal of the Royal College of Physicians, given for distinguished work in physiology, chiefly during the past two years, was presented on October 19 to Prof. R. Magnus, professor of pharmacognosy in the University of Utrecht.

UNDER the auspices of the Australian Salon of Photography (Box 298 F, G.P.O.), Sydney, New South Wales, the second International Exhibition of Pictorial Photography will be held on June 7-19 next. The latest date for receiving pictures will be May 3. Pictures from overseas may be mounted or unmounted, but must not be framed, and the Customs authorities require that a value should be placed on each.

▲ IN Our Astronomical Column of September 19, p. 445, reference was made to the series of articles on the changes of view in astronomy during the past year or two, which Prof. H. N. Russell is contributing to the *Scientific American*, beginning with the September issue. We are informed by the associate editor of that journal that Prof. Russell has contributed a monthly signed article to the *Scientific American* on current trends in astronomy since 1900.

A PAPER on "Science and Industry, Some Impressions from the Early Experiences of the British Non-Ferrous Metals Association" is to be presented by Dr. R. S. Hutton and Dr. O. F. Hudson, before the London Local Section of the Institute of Metals, on November 12. The meeting will be held at the Royal School of Mines, South Kensington, S.W. 7, at 7.30 p.m., and tickets can be obtained from the honorary secretary of the Section, Mr. W. T. Griffiths, Research Department, Woolwich, S.E. 18.

THE ninth lecture of the series "Physics in Industry," being given under the auspices of the Institute of Physics, will be delivered by Dr. B. A. Keen, Assistant Director of the Rothamsted Experimental Station, who will deal with "The Physicist in Agriculture, with Special Reference to Soil Problems." The lecture, which will be open to the public, will be given in the rooms of the Chemical Society, Burlington House, London, on Wednesday, November 25, at 5.30, and the chair will be taken by Sir William Bragg, president of the Institute.

THE establishment of sanctuaries for birds in the Royal Parks in Scotland, at Duddingston Loch in Holyrood Park, Edinburgh, and at Linlithgow Loch, has recently had the consideration of Lord Peel, First Commissioner of H.M. Works and Buildings, and a small committee has been appointed to investigate the matter. The members of the Committee are: The Right Hon. Lord Elphinstone (chairman), Dr. W. Eagle Clarke, Dr. James Ritchie, Mr. W. Home Cook, Surgeon Rear-Admiral J. H. Stenhouse, and Councillor T. G. Nasmyth. Mr. W. Wright, H.M. Office of Works, 122 George Street, Edinburgh, will act as secretary to the Committee.

THE Council of the Institution of Civil Engineers has made the following awards for session 1924-1925 in respect of selected engineering papers, published without discussion: A Telford Gold Medal to Dr. Andrew Robertson (Bristol), a Telford Gold Medal and the Indian Premium to Mr. S. A. S. Bunting (Bombay), Telford Premiums to Messrs. A. D. Swan (Montreal), C. H. Cruttwell (New Ferry), J. W. McLaren (Newfoundland), and J. L. Hodgson (Eggington); and a Webb Prize to Mr. A. R. Johnson (Penang), and in respect of papers read at students' meetings in London or by students before meetings of local associations during the same session: The James Forrest Medal and a Miller Prize to Mr. E. J. Rang (Tynemouth); and Miller Prizes to Messrs. D. Lloyd (Liverpool), H. F. Lea (Birmingham), H. A. Macnab (Glasgow), T. W. Marsh (Rochester), C. R. Smith (Manchester), and W. C. Knill (Gateshead-on-Tyne).

SIR CHARLES SHERRINGTON, president of the Royal Society, unveiled on October 19 the bronze memorial tablet to Sir Charles Wheatstone which has been placed in St. Michael's Church, Gloucester, by the City authorities. The ceremony marked the fiftieth anniversary of the death of Wheatstone, the pioneer of the electric telegraph. A number of instruments and pieces of apparatus designed by Wheatstone himself, or in collaboration with Sir W. F. Cooke, are preserved in the Science Museum, South Kensington. These have been brought together on this occasion in Gallery XXVI. of the new buildings and will remain there as a special exhibit for a fortnight. Early examples of stereoscopic apparatus; of two-, four-, and five-needle telegraph instruments, of his automatic telegraphic transmitting and receiving instruments, and of typewriting machines, are among the exhibits.

THE Egyptian Government Almanac for 1925 has been carefully revised and contains much useful information, among which certain chapters are of scientific interest. Agriculture and industries are fully treated, and there is an account of the various measures for the improvement of crops and combating plant diseases which are being undertaken by the Ministry of Agriculture. A chapter on the Nile gives a condensed account of the regime of the river.

COLOURED pictorial supplements form a feature of recent numbers of the *World's Health*, the monthly review of the League of Red Cross Societies. They illustrate the posters which are issued by the League for health propaganda and are adapted for the respective countries where they are to be utilised. Thus, in the July number the poster reproduced is that for India, and depicts various scenes in native dress and surroundings illustrating common dangers to health, e.g. the risk from flies on food, the danger of sleeping with consumptives, etc.

THE Carnegie Institution of Washington has published an account by Dr. Chester Stock of the Cenozoic gravigrade edentates of western North America, in which the Megalonychidae and Mylodontidae of the celebrated Rancho La Brea deposits come in for special consideration. The genera *Nothrotherium*, *Megalonyx*, and *Mylodon* are fully described from excellent material, and the account is fully illustrated by 47 plates and 120 text figures. Attention may be directed to the excellent quality of these text figures, both as to drawing and reproduction; the publication reflects great credit on author, as well as his artists and printer.

THE report of the annual meeting of the Indian Botanical Society held at Benares on January 12 last shows an active society in existence, with a membership of 171, which has assumed responsibility for the *Journal of Indian Botany*, edited by Prof. P. F. Fyson, and is doing its best to unite botanists in India in the task of promoting botanical survey and investigation. The report includes the presidential address by Prof. Shiv Ram Kashyap, an interesting account of the vegetation of the western

Himalayas and western Tibet, illustrated by some striking photographs of the cushion-like, shrubby perennial plants which alone can thrive in the cold dry winds in many of the desert regions of the Tibetan plateau.

A FOURTH part of the important work "Trees and Shrubs of Mexico," published as volume 23 from the United States National Herbarium, has recently appeared. In this volume the families Passifloraceae to Scrophulariaceae are dealt with by Mr. Paul C. Standley, assistant curator to the Herbarium, but Mr. Ellsworth P. Killip deals with the family Passifloraceae, whilst about 150 pages are devoted to an account of the Cactaceae of Mexico by Dr. N. L. Britton and Dr. J. N. Rose. That these authorities could deal with the Cactaceae is very fortunate, as a greater number of species of this family occur in Mexico than in any other part of the globe. The present volume contains pages 849-1312, with an index of species in an additional 39 pages.

THE annual report of the National Institute for the Blind (1924-25) supplies some interesting reading, which may come as a surprise to those unacquainted with its many-sided activities. There are homes for blind babies, a massage school, a college for blind girls, a guest house, and a hostel, in addition to departments concerned with the publication of Braille embossed books, with the training and after-care of the adult blind, with the supplying of materials for the blind to work with in their homes, etc.; in addition, technical and research work is undertaken with the object of still further alleviating the lot of the blind. The work is of the utmost importance, first, because by adequate training the separation of the blind from their fellows is minimised, and secondly, it is of interest to all scientific people, for by a study of those deprived of one sense we gain some insight into the part played by that sense in the normal person.

MR. CHARLES NOWELL, librarian of the Coventry Public Libraries, sends us a class-list of the periodical publications currently displayed in the city libraries. The list contains entries of no less than 623 publications, exclusive of annuals, and includes the large number of 60 periodicals devoted to motor engineering. Many of these works are no doubt presented to the library; but it is evident that Coventry does not stint expenditure in the purchase of the more expensive publications. For example, nine of the current co-operative periodical indexes and professional abstracts are taken in, such as the Subject Index to Periodicals, the Wilson Co.'s Indexes, Chemical Abstracts, and the Abstracts of the Metal Institute. Against the entry of each periodical in the list is a number indicating in which of these nine indexes and abstracts the periodical in question is analysed. This is a novel and valuable feature in class-lists of the above nature, and we commend it to the notice of other librarians. The list is being sent gratuitously to firms and individual residents who are likely to be interested in its contents. The work is well printed and arranged, and reflects credit upon all who have taken part in its compilation.

A CATALOGUE, recently issued by Messrs. J. W. Atha and Co., Winsley House, Wells Street, Oxford Street, London, W.1, the British agents for Messrs. Carl Zeiss of Jena, contains a description of all modern types of Zeiss microscopes and accessories. The particulars given indicate the many important changes that have been made by Messrs. Zeiss, during the past few years, in the construction of the optical and also the mechanical parts of their microscopes. A new form of mechanism is applied to all their stands for the production of the slow micrometer motion. In this mechanism, the motion is transmitted by accurately cut, toothed wheels. The reaction of a spring ensures continuous pressure in the direction of motion, so that there is no backlash. The component lenses of the objectives are now mounted in small cylinders, which are finally assembled one above the other within a hollow cylinder. This mode of mounting obviates such centring defects as were liable to be introduced in the course of the screw assemblage formerly adopted. The accessories have also been remodelled and improved, and many new and useful devices have been added. Among these may be mentioned the change-over condenser for bright and dark background illumination, the micromanipulator which enables an observer to operate on the smallest microscopically perceptible objects, and special eyepieces, such as the stereoscopic eyepieces, the photographic eyepiece, and the comparison eyepiece.

MESSRS. Reynolds and Branson, Ltd., of Leeds, have recently issued a new edition of their well-known catalogue of chemical and physical apparatus and chemicals. A feature of this publication is its division into sections, each complete in itself, which can be easily found by means of thumb-indexes distinctively marked and coloured; and the relatively small size of the book (9½ in. × 6 in.) makes it much more easy to handle than ordinary catalogues of this nature. Of the nine sections into which the book is divided, that on optical projection apparatus strikes one as being especially valuable and comprehensive, whilst the photographic reproductions and diagrammatic plans of chemical and physical laboratories, designed and fitted by this firm, cannot fail to interest all heads of departments in schools, colleges, and factories.

READERS interested in Latin America should apply to Mr. F. Edwards, 83a High Street, Marylebone, W.1, for Catalogue 472 relating to books, etc., dealing with Central and South America, British Guiana and the Falkland Islands. Nearly 700 works are offered for sale.

No. 797 of "Sotheran's Price Current of Literature" has just been circulated by Messrs H. Sotheran and Co., 140 Strand, W.C.2. Like its predecessors, it contains many bibliographic notes of interest and value on the works listed, of which there are some 1465 titles. The catalogue includes the library of the late Mr. J. E. Campbell, F.R.S., and a selection from that of Prof. A. R. Forsyth, F.R.S. It should be seen by all mathematicians on the look-out for additions to their libraries.

MESSRS. Bernard Quaritch, Ltd., 11 Grafton Street, W.1, have just issued Catalogue No. 394, which gives particulars of many rare books on astronomy, chemistry, engineering, mathematics and physics, offered for sale by that firm. An item of great interest in the catalogue is "The Wooden and Metal Numbering Rods called Napier's Bones," being the actual calculating instrument invented and used by Napier. The box containing the rods bears the inscription, "This box was the identical property of the author of *y^e Log^s*. Napier 1824."

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just issued Part 3—Invertebrata—of their Zoology Catalogue. It contains nearly 4000 titles arranged under the headings Mollusca, Insecta, Economic Entomology, Parasitology, Arachnida, Myriapoda, etc., Crustacea, Vermes, Echinodermata, Coelenterata, Protozoa, Aquaria, Marine Biology, Microscopy, and Miscellanea. We notice that the same firm offer for sale as a whole the collection of pamphlets and separates mainly on entomology formed by the late Dr. Péringuey, of the South African Museum.

AN extensive variety of instruments is contained in a catalogue of second-hand scientific apparatus which has just been issued by Mr. C. Baker, 244 High Holborn, London, W.C.1. Microscopes and microscope accessories, surveying and drawing instruments, spectroscopes and projection apparatus, telescopes and binoculars, astronomical instruments ranging from students' models to large equatorials, and apparatus for general physical measurements, are detailed in classified lists, which contain, in all, about 2500 items, and each item is priced. The apparatus and instruments have all been tested and are guaranteed by the firm to be in perfect adjustment before being offered for sale. Copies of the catalogue can be obtained on application being made to the firm.

MESSRS. Dulau and Co., Ltd., 34 Margaret Street, W.1, have just circulated an interesting and useful catalogue (No 132) of second-hand gardening books and botanical and horticultural works. Of the 1100 odd books offered for sale, many are from the libraries of the late Sir Isaac Bayley Balfour, Mr. C. Harman Payne, and Mr. William Watson. Copies of the catalogue can be obtained free upon application.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: A lecturer in agriculture and farm costings at the Hertfordshire Agricultural Institute, Oaklands, St. Albans—Clerk of the County Council, 28 Castle Street, Hertford (November 3). A director of the botanical and plant-breeding section of the Ministry of Agriculture, Egypt, and an economic botanist—The Egyptian Legation, 7 Charles Street, W.1, or the Under-Secretary of State, Ministry of Agriculture, Cairo (November 20, endorsed "Research Staff"). A laboratory steward at the Central Secondary School, Sheffield—Headmaster.

Research Items.

THE "SUN GOD" IN INDIAN ART.—The development in the iconography of Sūrya in Brahmanical art is the subject of a study by Jitendra Nath Banerjee which appears in the September issue of the *Indian Antiquary*. In Vedic ceremonies symbols such as the spoked wheel, rayed disc, etc., were used to represent the sun. Anthropomorphic images of the sun god do not appear until late in Indian art owing to the disappearance of monuments, other than Bhuddist, prior in date to Asoka. The characteristic features of the type of the sun-god images which have been discovered in Northern India are top-boots, a close-fitting bodice-like garment, and a waist zone which has been identified with the sacred woollen girdle of the Zoroastrians. This type has been assumed to be Iranian, derived from Mithra; but the anthropomorphic representation of Mithra is due to the Hellenisation of Mithra and is derived from Apollo-Helios. The type first appears in India on a coin of Kamaska. The medieval booted sun god of India is thus derived from the Hellenistic Apollo with certain added characteristics—the boots and heavy tunic—to be attributed to the Scythian invaders who followed the Hellenes. Ingenious myths were invented to account for these alien characteristics. In Southern India they were forgotten, and the sun god is there represented without his boots and heavy draperies.

THE ETHNOLOGY OF NEW ZEALAND.—In Vol. 2 of the Cawthorn Lectures (Cawthorn Institute, Nelson, N.Z.) Te Rangi Hiroa (P. H. Buck) surveys present knowledge bearing upon the question of the origin and composition of the Maori and pre-Maori population of New Zealand. The traditional settlement of New Zealand is analysed into three periods: (1) a pre-Toi settlement occurring a fairly long time before A.D. 1150; (2) the Toi expedition of A.D. 1150; (3) the Hawaiki migration of A.D. 1350, which was composed of the Fleet of five vessels with the well-known canoes. The Toi people failed to bring cultivable food plants, though acquainted with them. As they were a mere handful among a numerous people of food gatherers, agriculture as well as a number of useful arts disappeared until introduced by the later migration. A detailed study of culture areas has still to be made, but the Southern culture appears more typically Polynesian than the Northern, which contains elements pointing to Western affinities from a non-Polynesian source. Among the Moriori of Chatham Island there are long-headed and broad-headed elements associated with a narrow nose; but there is complete absence of the broad-nosed Melanesian type. On the mainland, Melanesian and broad-headed elements of two types, which appear especially in remoter areas, are present. It thus appears that there were really two distinct waves of pre-Toi people coming from different regions and having distinct characteristics, one from Eastern Polynesia, the other from the Western Pacific area and bringing with it a culture with non-Polynesian elements.

SECTIONS OF THE HUMAN EYE.—A series of seven photomicrographs of sections of the human eye, the work of E. F. Fincham, are reproduced in the Transactions of the Optical Society, Vol. 26, No. 3. Several of these illustrate the distribution and size of the rods and cones in different areas of the retina. A transverse section through the bases of the rods and cones in a peripheral part of the retina shows their irregular arrangement. Here and there in this region two cones are in contact with one another, and there is a much greater number of rods than cones. The

maximum diameter of the rods is 1.5μ , while that of the cones is 6μ . At the border of the fovea, the cones exceed the rods in number. Here the maximum diameter of the cones is 4.5μ . Nearer the centre of the fovea they are smaller, measuring only 3μ , and very few rods are present. The foveal cones shown in another photograph are thin and elongated, the maximum diameter being 2μ . No rods are seen in this area. The hexagonal section of the cones and their packing at the fovea, as described by Helmholtz, are well illustrated in a photograph (magnification, 1000) of a transverse section of the cones in that region. Another interesting photograph is that of a section of the ciliary region of the eye, which has been so cut as to expose a complete zonule fibre extending from the inner surface of the ciliary body towards the anterior capsule of the lens.

HERRING INVESTIGATIONS.—A first report on the investigations made by the Ministry of Agriculture and Fisheries with regard to the age, length, and maturity of the herrings of the southern North Sea is given us by Mr. W. C. Hodgson (Fish. Invest. Ser. II., vol. 7, No. 8, 1924). The Norwegian scale theory has been accepted by the Ministry as a working hypothesis. The calculated sizes of the fish at the formation of the first winter ring show variations, and these group themselves about 8, 10, and 12 cm. For these three groups corresponding stages of young fish have been found in the winter. It is stated that a foundation for solid investigations will have been laid when the origin of these groups has been established and when it can be said a given year-class comes from a certain spawning. Growth, as shown by the scales, was found to begin in April and cease in September. The younger fish began their growth earlier and had a longer growing period than the older fish. From data obtained during the period May to October 1924, it is shown, for fish with four zones on the scales, that growth was most active during May and June, and in September it slowed down considerably. These data give a curve which shows close agreement with the observations made by Hardy on the feeding of the herring.

—EVOLUTION BY HYBRIDISATION.—Dr. L. Cockayne states that amongst the vascular plants of New Zealand, 206 wild hybrids are known between Linnean species. In these circumstances it was a natural and happy idea to invite Dr. J. P. Lott to visit that dominion, study the vegetation, and give some lectures upon his views as to the part played by hybridisation in evolution. These lectures are now published by Carterbury College under the title "Evolution considered in the Light of Hybridisation," and provide a useful brief statement in English of the reasons why Dr. Lott attaches such significance to sexual reproduction and the possibility of hybridisation in connexion with the process of evolution. He precedes the statement of his own views with a very trenchant examination of theories of transmissible variability, whether neo-Lamarckian or mutationist.

THE SOURCE OF SANTONIN.—T. E. Wallis and Ellinor J. Mowat, of the Pharmacy Research Laboratory, have done a useful if laborious piece of work in clearing up the systematic position of various samples of Artemisia, the worm-seed of commerce from which santonin is prepared. Microscopic examination of the foliage leaves and the tracts of the flower head has made it clear that the true source of the drug is *Artemisia Cina* (Berg) Willkomm, which is a different species from that given in the British Pharmacopoeia, whilst yet another species is given in the United States

Pharmacopœia. Seven commercial specimens devoid of santonin were examined and could be distinguished by the hairiness of the leaves and other minute characters. The specimens thus examined seemed all to be of the same species, but unfortunately it still remains unidentified.

INDIAN BAMBOOS FOR PAPER PULP.—*Indian Forest Records*, vol. 11, part ix., records the very successful large-scale trials by Mr. W. Raitt of his methods for utilising the bamboos and savannah grasses of India as material for paper pulp. The methods now successfully applied at the Forest Research Institute, Dehra Dun, with a small plant capable of handling 20 tons a week, are based on prolonged laboratory experiment, and, as is stated by Mr. R. S. Pearson, Forest Economist, in a preface, it appears that they "at once bring the utilisation of bamboo for paper pulp on to an absolutely sound foundation." The key to the method seems to lie in a process of "fractional digestion," in which a large bulk of soluble material, mainly carbohydrates, is got rid of by the use of dilute alkali, thus preventing dark-coloured decomposition products, which arise from these soluble compounds in time, from staining the final cellulose product. At the same time economy of alkali is effected as stronger percentages are only used on a smaller bulk of material at a later stage, whilst the high density of soda then used enables both time and temperature to be reduced in the process of lignin digestion, which follows upon the removal of the more soluble products. The lignin hydrolysis yields a clear liquid which can be removed from the pulp with great facility without leaving any stain. The large paper mills of India are said to be adapting their plant to this "Fractional Digestion" system. It deserves consideration outside the bounds of India: thus Prof. F. W. Oliver has described experiments on the utilisation for paper-making of spartina, the grass which is now colonising vast sheets of mud in the neighbourhood of Southampton, and was studied with interest by many members of the British Association this year. Prof. Mangham gives a brief account of this grass, with some striking photographs, in *Conquest* for September 1925.

AMMONITES OF THE FAMILY ECHIOCERATIDÆ.—The importance of Ammonites as zone fossils, and as affording clear evidence of evolutionary processes in the past, has led to their intensive study in an ever-increasing degree. Buckman's work on them in this direction is well known, and the studies initiated by him have been taken up by various successors. The latest and a most valuable contribution is one by Dr. Trueman and Miss Williams entitled "Studies in the Ammonites of the Family Echioceratidæ" (*Trans. Roy. Soc., Edinburgh*, 53, pt. 3), members of which have been most frequently recorded in the past as *Ammonites raricostatus*. After discussion of general considerations, the authors proceed to systematic descriptions. Here they increase the five genera which they found when they took up their investigations, by the addition of nine new ones. In making these genera, and in indicating their limits, attention was paid so far as possible to the presumed phylogeny of the family, but the authors suggest the possibility that further researches may entail the foundation of yet others. This implies, of course, the creation of additional new species to the thirty-three such named in the present paper. There is a short but sufficient section devoted to the stratigraphical distribution of the family as well as an altogether admirable series of excellent plates.

AN ARCTIC OIL OCCURRENCE.—In a short bulletin of the United States Geological Survey (No. 772), by

Messrs. Paige, Foran, and Gully, some details are given of the results of an expedition to the Point Barrow region of extreme northern Alaska in 1923, made primarily to search "Naval Petroleum Reserve No. 4" for evidence of petroleum. The expedition seems to have been quite successful despite the remoteness of the area, inaccessibility, rigid climatic conditions, and other obstacles to routine survey, and two large oil seepages at Cape Simpson were discovered. Practically the entire area of this Naval Oil Reserve lies north of the sixty-ninth parallel, and thus comes well within the Arctic Circle. The Cape Simpson seepages seem to emanate from Mesozoic rocks (Upper Jurassic or Lower Cretaceous), which are the predominating rocks of the Point Barrow region, but owing to the drift and moss-covered character of the coastal plain country and absence of contiguous solid rock, it has so far been found impossible to discover definite relationships between the petroleum and local geology. It is clear from the tests carried out on samples of the oil, however, that it is much inspissated, and probably has migrated from considerable depths. It showed a specific gravity of 0.943 and contained 6.36 per cent. of sulphur and 7.5 per cent. of water, distillation indicated chiefly gas oil and lubricant fractions, lighter products having evaporated. The results of these tests, coupled with the available geological evidence, justify a continuation of the explorations, and a further expedition has been sent out at the instigation of the United States Naval Department to prove the value of the discovery.

UPPER AIR TEMPERATURES IN EGYPT.—The Meteorological Office, Air Ministry, in Professional Notes, No. 41 (London: H.M. Stationery Office, 3d. net), by Mr. E. V. Newnham, discusses upper air temperatures in Egypt. The discussion refers to observations made at Ismailia and at Helwan. Mean values of temperature corresponding with pressures of 950 or 900 to 650 or 600 millibars are given, and these are taken to be also the means corresponding with the average heights at which these pressures occurred. The difference between the mean temperatures for January and August are given, these being the months with lowest and highest means at all heights, and some figures for south-east England are added. The range with height is seen to be rather greater in Egypt than in south-east England. At a height of about 3300 ft. the lowest temperatures occur generally with winds having at least some component from north and often with nearly due north winds; the directions corresponding with the highest temperature are very variable. At 12,000 ft. and 14,000 ft. the fluctuations of temperature are much smaller, and they do not correspond very closely with the fluctuations lower down. The discussion is a praiseworthy effort to advance our knowledge of the general circulation of the atmosphere.

A HIGH ALTITUDE OZONE LAYER IN THE ATMOSPHERE.—In the *Comptes rendus Acad. Sci.*, Paris, August 24, Messrs. J. Cabannes and J. Dufay describe observations on absorption bands due to ozone in the spectrum of the sky at the zenith, in the middle of the day and towards evening, in which their relative intensities were compared. The mass of ozone traversed by vertical rays reaching the ground is equivalent to a layer of the pure gas at atmospheric pressure with a mean thickness of 0.3 cm., and if this gas were uniformly distributed in the atmosphere the amount in that portion of it in which ordinary determinations can be made would be about ten times as great as that actually observed. The natural conclusion is that the amount of ozone is greater at high elevations than lower down, and since the light

passing through this high layer of ozone strikes it more nearly perpendicularly in the middle of the day than in the early morning or the evening, the absorptions will differ. In either case the light passing through this layer will be diffused by the air into which it passes, and will be observed as sky light. The authors deduce from their measurements a height of about 50 km. for the ozone-rich layer of the atmosphere, 48 km. from observations on March 10, 53 km. for June 4, and 48 km. for June 8.

RADIATION DUE TO ELECTRONIC BOMBARDMENT.—An article in the *Zeitschrift für Physik* for July 18, by Prof. G. Mie, deals with the relation between the radiation produced by bombardment with swift electrons (*Bremsstrahlung*) and the new emission theory of Bohr, Kramers, and Slater. It is difficult to reconcile the existence of this "braking radiation" with the new theory. When an electron enters an atom with a high velocity it travels in a hyperbolic orbit, and may jump from this into a hyperbolic orbit with smaller energy, or even into an elliptical orbit, with an emission of braking radiation. According to the new theory of emission, radiation takes place during the time before the jump, when the electron is moving in the higher orbit; but it is difficult to see how this can take place for the braking radiation, since an electron moving in a straight line with uniform velocity certainly does not radiate, and the short time during which it remains in the hyperbolic orbit near the nucleus will not suffice for the emission of a long wave train. It seems necessary to assume that the electron itself can act as an oscillator, and that a free electron at a distance from any atom can take on an infinite number of conditions in each of which it contains a different amount of internal energy. In an ordinary stream of electrons, each of them is in the most stable condition and does not radiate, but when one of them meets an atom it may undergo a collision of the first kind and a portion of its kinetic energy will be suddenly converted into internal energy, the electron passing into a higher valued condition. It will at once begin to radiate with constant intensity, and with a definite wavelength, until it either falls back into the most stable condition at the end of the natural "life" (*Verweilzeit*), or possibly until before this it loses its capability of vibration as the result of a collision of the second kind, and again gains kinetic energy. Collisions are also possible in which the atom absorbs or gives out energy. Compton's scattered radiation is the fluorescent radiation of the free electrons, which are excited by optical resonance. If they radiate undisturbed to the end they form the recoil electrons; if their radiation is stopped by a collision of the second order they form the swift photo-electrons.

TERNARY ALLOYS OF IRON, CARBON, AND NICKEL.—Owing to their industrial importance, many papers have been published on the constitution of nickel steels, but there has as yet been no systematic study of the ternary alloys of iron, carbon, and nickel. T. Kaser, in the 104th Report from the Institute for Iron, Steel, and other Metals, Japan, gives an account of his investigations on the equilibrium of this system. The chief previous investigations on the binary alloys have been carried out by Ruer and Schütz, and by D. and H. Hanson. The present author has also investigated the binary systems, iron-nickel and nickel-carbon. He finds that carbon and nickel form a eutectic at a concentration of 2.22 per cent. of carbon and a temperature of 1318°C . The solubility of carbon and nickel is 0.55 per cent. at the eutectic temperature, and about 0.25 per cent. at room temperature. In the ternary system the author finds no ternary eutectic, but a binary eutectic of a

solid solution consisting of iron-nickel and carbon. The sum of the combined and dissolved carbons in the ternary alloys at room temperature rapidly decreases to 0.30 per cent. in 30 per cent. nickel-steel, and afterwards remains constant. The field representing the existence of cementite in the ternary alloys has been determined. It almost coincides with the range in which combined or dissolved carbon exists. With the addition of nickel the A1 transformation is lowered and is scarcely visible at 10 per cent. As the nickel content increases, the carbon content in the eutectoid compound decreases down to 0.30 per cent. at about 35 per cent. of nickel.

A NEW LOCAL ANÆSTHETIC.—The British Drug Houses, Ltd., have prepared a new substitute for cocaine, called borocaine, which is an efficient, non-toxic, surface anæsthetic. The original paper on borocaine, by Copeland and Notton, appeared in the *British Medical Journal* for September 25. It is prepared as a soluble white crystalline powder and is the borate of ethocaine.

A SIMPLE PRECISION CRYOSTAT.—In the *Journal of the American Chemical Society* for September a simple precision cryostat is described, a modification of that of Henning, able to maintain any required temperature from 0° to -180° for three hours. The liquid in the bath, gasoline for temperatures to -140° and butane for temperatures to -180° , is cooled by aged liquid air flowing through a copper spiral, under pressure of a hand-regulated water-head, at such a rate that the bath tends to become too cold. Temperature change is shown by a sensitive galvanometer used as a null instrument, a heating coil in the bath being operated by a switch to restore the needle to zero. The maximum error at -150° is 0.01° and at -180° is 0.015° .

ESTIMATION OF OXYGEN.—It has been known since 1863 that the estimation of oxygen of high purity by adsorption in alkaline pyrogallol solution is rendered inaccurate by the liberation of carbon monoxide. The results of some work on this subject by Drakely and Nicol appear in the *Journal of the Society of Chemical Industry* for September 25, 1925. They recommend the use of a solution prepared by adding 15 gm. of pyrogallol to 100 cc. of potash solution of $d = 1.55$, in the usual gas analysis vessels; agitation is of utmost importance; the solution must not be used after absorbing one-tenth of its specific adsorption volume, and the oxygen content of the gas should be reduced to 25 per cent. with nitrogen. With these precautions the analysis may be considered sufficiently exact for industrial purposes.

CATALYTIC ACTIVITY OF THIN FILMS.—The results of some experiments on the catalytic activity of thin films of nickel and platinum in the reaction $\text{C}_2\text{H}_4 + \text{H}_2 \rightarrow \text{C}_2\text{H}_6$ are published in the September *Journal of the American Chemical Society*. Thin films of nickel and platinum were deposited on glass wool in evacuated vessels by electrical heating of filaments coated with these metals. The mixture of gases containing 20 per cent. ethylene and the catalyst were heated to 200° , but no reaction was observed. Similar negative results were obtained when oxygen and water vapour were admitted. The results indicate that the importance of the extent of surface has been overestimated. From the method of preparation of the surface it is likely that the electronic configuration of the molecules in the film is the same as that in the bulk metal and differs from that in the catalyst prepared by the reduction of the oxide. It is supposed that the surface of the catalyst consists of molecules having electrons on different energy levels from those in the crystalline metal.

Palæontologists at Weimar.

THE annual meeting of the international Palæontological Society, which, as already announced in *NATURE*, was held in Weimar on September 24 to 30, was attended by about sixty members. Germans naturally predominated, but Austria, England, Hungary, Russia, and Sweden were also represented.



FIG. 1.—At the bottom of the Kämpfe Quarry in the travertine of the Ilm terrace near Ehringsdorf, Weimar. The white paper label marks the level of the Mousterian culture-layer.

Weimar is a delightful town in which to stay, but the historical interest of the best available meeting-room scarcely outweighed its unsuitability for a modern scientific conference, nor did the rainy weather conduce to the pleasure of the excursions. On the other hand, the immediate neighbourhood has, during the past few years, furnished the Weimar Museum für Urgeschichte with a remarkable series of Pleistocene remains, which have been studied and arranged mainly by Prof. W. Soergel and Custos Moeller. These come from the travertine and gravel deposits of the Ilm valley. An excursion had been planned to the travertine quarries of Ehringsdorf, where in the lower beds is to be seen a culture layer of Mousterian age. In clearing a fresh surface of this layer for inspection by the palæontologists, the unexpected discovery was made of a battered skull of Neanderthal type embedded among the charred fragments of wood and bone. The mode of occurrence suggested that this might be a case of cannibalism. Another recent find, announced by Prof. Freudenberg, was of human bones from Mauer, possibly belonging to the original *Homo heidelbergensis*.

Inspired by the morphology of Goethe, Prof. Jaekel opened the proceedings with a most interesting lecture on the problem of the skull. His main conclusion was that the primitive skull consisted of four parts, two in the cranium, two in the lower jaw, with the addition of a quadrate. Prof. Sewertzoff, on the other hand, claimed for the primitive cranium a large number of ossification centres. The Russian morphologist also discussed the origin of the quadrupeds. Dr. Ehrenberg attempted, from his studies of cave-bears, to throw some light on the epiphysis found at the back of the head in young skulls. Prof. Jaekel introduced a Devonian fossil as a direct ancestor of the sturgeons, in which case the Liassic

sturgeons would be a side-branch. Prof. Wiman discussed minor points in the skeleton of Mesosauria, Dr. Gürich showed photographs of Triassic Deinosaur foot-prints from German S.W. Africa, and Dr. Schmidtgen described a huge *Elephas trogontherii*, with a pelvis 183 cm. wide, recently obtained by the Mainz museum. The most fundamental paper on vertebrate anatomy (scarcely palæontology) was by Prof. Weidenreich of Mannheim, who demonstrated a continuity of the organic stroma from bone, through dentine, right into the enamel of the teeth.

Among the papers on fossil invertebrates may be mentioned Prof. Kessler on the siphonal structures of various cephalopod shells, illustrated by many preparations, including some transparent specimens from Spitsbergen; Dr. Scheurlen on pustulate ammonites from the Upper Brown Jura, showing that various species of *Strigoceras* were really growth-stages of a single species; and Dr. Beurlen on some stratigraphical and palethological questions concerning Jurassic Crustacea, in which Eryon was regarded as tending towards *Brachyura*. *Arenicoloides* was the subject of papers by Prof. K. Andrée and F. A. Bather, the former regarding it as identical with *Diplocraterion* (Torrell) and *Arthraria* (Billings), the latter seeking to explain it by similar structures in the Yorkshire estuarine oolites. The curious markings and other peculiarities of the Flysch were held by Prof. Abel to indicate formation under the conditions of a Florida mangrove-swamp.

Two papers of historical interest directed attention to modern evolutionary views in pre-Darwinian works,



FIG. 2.—A block of the Mousterian culture-layer showing the battered Neanderthal cranium *in situ* as found.

Prof. Wüst dealing with Ludwig Rütimeyer (1825–1895) and Prof. Pompeckj with Reinecke (1818).

The meeting was brought to a close by an excursion to Jena, where members were invited to a special demonstration of the marvellous Zeiss planetarium; that at Munich was described in *NATURE* (December 27, 1924), and we believe there will soon be one in London. Then followed an inspection of the Phyletic

Museum, under the guidance of Prof. L. von Plate. In the afternoon members examined the Muschelkalk at Gdschwitz, where the rock is worked on the plateau in a succession of funnel-shaped quarries. A tunnel leads to the bottom of each funnel and the rock is tumbled down into the waiting waggons, which are transported by an aerial line to the cement works in the valley. Since the rock is cut out in steps, each quarry resembles a Roman amphitheatre, but with no arena. Thus ended an exceedingly interesting meeting, at which one would like to have seen more palaeontologists from the British Isles.

Cotton-Growing in the British Empire.

A USEFUL account of the present position of cotton-growing in Uganda is given by Col. C. N. French in a recently published report to the Empire Cotton-Growing Corporation on his tour through the cotton areas of Uganda, Kenya, and the Mwanza district of Tanganyika. The rise and promise of Uganda as a cotton-producing region are well known. Under the careful guidance of the agricultural department, cotton has become by far the most important export of the country, the annual production amounting to nearly 200,000 bales. Practically the whole of the crop is raised by the natives, who send their seed cotton to the ginneries established at convenient centres under European or Indian control. The type at present grown is a variety of the famous "Nyasaland Upland". The quality of the cotton is good and the yield not unsatisfactory, while so far no serious pests have been encountered. Col. French considers that for the time being the producing area should not be extended, but efforts made to consolidate the present position by the application of science and improved agricultural methods with the view of producing increased quantities of cotton of better and more uniform quality from the area already under cultivation. He believes that the most immediate need for the attainment of this object is the strengthening of the scientific side of the agricultural department, and he puts forward suggestions for the reorganisation he considers desirable.

A further illustration of the work of the Empire Cotton-Growing Corporation is afforded by the "Reports from the Experiment Stations for the Seasons 1923, 1924, and 1925 (South Africa only)." In South Africa, F. R. Parnell has established the fact that resistance of the cotton plant to the attacks of "jassid" (*Chlorita fascialis*, a small winged bug forming a menace to cotton-growing in the lower veldt) is hereditary, and considerable progress has been made in the direction of breeding a jassid-resistant variety of cotton. R. C. Wood reports on the selection and other experimental work carried out at Mpanganya (Tanganyika). One of the varieties resulting from the selections made in 1922 will be the first seed to go out into general cultivation (it is hoped) in the season 1926-27. The work of establishing and laying out the experiment station at Makwapala (Nyasaland) during 1924 is described by H. C. Sampson, while details of a variety test with Sea Island cotton in St. Vincent, B.W.I., are recorded by L. H. Burd. This latter work was undertaken with the object of investigating the relationship, if any, existing between the yield and other "growing" qualities of the cotton plant, and the spinning characters of the fibre. The inconclusive results illustrate the difficulty of complicated work of this nature, but an encouraging practical outcome of the experiments is the evidence afforded by the spinning tests (carried out by the Experimental Department of the Fine Spinners' and Doublers' Association) of the superiority of all the strains of

cotton tested over the control standard sample of West Indian cotton: reduction of comber waste was considerable, and in one case a superiority of 47 per cent over the control cotton as regards the relationship between hair strength and weight of lint was recorded.

The Empire Cotton-Growing Corporation has evidently recruited men of overseas experience in addition to scientific knowledge in their task of widening the area under cotton cultivation in the British Dominions Overseas. The October number of the *Empire Cotton Growing Review* contains reports of their activities in all parts of the Empire. H. C. Sampson points out how cultivation implements adapted from Indian experience may be applied to cultivation with native labour in East Africa, whilst Col. C. N. French discusses the possibility of adapting the methods of administration of large-scale estates in the Punjab to the problems of cotton-growing in the Mandated Territory of Tanganyika. Mr. Youngman describes the short staple Oomras cotton and the factors leading to the cultivation of this coarse type of cotton in a vast area of Central India. It is thus once more apparent what a reservoir of experience to be applied in problems of tropical administration is rendered available through Britain's long responsibility for India's development. In a review dealing with cotton-growing, insect pests are naturally well to the fore, and H. A. Ballou discusses them in general relation to cotton, F. R. Parnell's work on breeding jassid-resistant cottons is also described, whilst incidentally, in discussing insect pests under Australian conditions, E. Ballard gives it as his experience that jassid infestation is only serious when the soil is very poor, e.g. deficient in potash.

University and Educational Intelligence.

APPLICATIONS are invited by the Harveian Society of London for the Buckston Browne prize, consisting of a medal and 50*l.*, for the best essay on "The Etiology of High Blood Pressure and of the Respiratory Phenomena associated with High Blood Pressure and Chronic Nephritis." The latest date for the receipt of essays is November 1, 1926. Particulars of the competition may be obtained from Dr. G. de Bec Turtle, 81 Cambridge Terrace, Hyde Park, W.2.

THE President of the Board of Education and the Minister of Labour have appointed a committee "to inquire into and advise upon the public system of education in England and Wales in relation to the requirements of trade and industry, with particular reference to the adequacy of the arrangements for enabling young persons to enter into and retain suitable employment." The committee consists of Mr. Dougal O. Malcolm, Miss Violet Markham (Mrs. Caruthers), Mr. Max J. Bonn, Mr. W. B. Kennick, Mr. Arthur Shaw, Mr. Christopher H. Turnor, and Mr. D. Milne Watson. Mr. H. B. Wallis, Board of Education, and Mr. W. H. Lowe Watson, Ministry of Labour, are joint secretaries, and all communications should be addressed to them at the Ministry of Labour, Montagu House, Whitehall, S.W.1. The absence from the committee of any one familiar with the place of science in education, or education in science, is particularly noteworthy. Oxford and Balliol predominate in the membership of the committee, and they represent the characteristic official attitude towards scientific teaching or its relation to modern needs.

A NEW Diploma Course in Agriculture is announced by the Edinburgh and East of Scotland College of Agriculture. Hitherto the College diploma course has extended over three years, like the degree course, from which it has differed but little in scope. Neither course has attracted more than a very few prospective

farmers. Nearly all those who have taken them have done so with the view of becoming teachers or departmental officials. The college authorities have determined that the new diploma course shall meet so far as practicable the needs of the ordinary farmer, and have therefore limited it to two winter sessions, and reduced to a minimum the purely theoretical instruction. The new regulations appear in full in the College Calendar for 1925-26. The subjects are agriculture, agricultural chemistry, agricultural botany, agricultural zoology, farm accounting and agricultural economics, land surveying and agricultural engineering, veterinary science, and agricultural law. The Calendar shows that during the past session the central classes were attended by 407 students, namely—day classes, 121, evening classes, 184; rural schools' course, 86, and farmers' class, 16.

The government of the Welsh National School of Medicine has formed the subject of prolonged consideration by the Council of the University of Wales, which has come to the conclusion that the School, at present governed by the Council of the University College of South Wales and Monmouthshire, assisted by a Board of Medicine and a Faculty of Medicine, should be constituted an independent School of the University. At a special meeting of the Court of the University presided over by the pro-chancellor, Lord Kenyon, on October 16, a resolution to this effect was submitted by Mr. William George, of Criccieth. It was asserted, as one of the grounds of the motion, that unless the School was made truly national it would be difficult and perhaps impossible to secure rate aid from the North Wales councils, and the Privy Council grant of 7000*l.* would not be available. The motion was opposed by Principal Trow, of the University College of South Wales. After discussion it was carried by 71 votes to 41. It is proposed to petition the Privy Council for a charter of incorporation for the School, the status of which in the University of Wales would thus approximate to that of the College of Medicine, Newcastle-on-Tyne, in the University of Durham.

The University of Leeds has launched a public appeal for half a million pounds for structural expansion and increased equipment. This sum is not far short of the total of the donations and subscriptions (excluding those of the Clothworkers' Company, amounting to about a quarter of a million) received by the University and the Yorkshire College of Science during the past fifty years. The appeal organisers have set themselves the task of raising it in ten years, hoping that it may be possible to proceed with the building programme meanwhile at the rate of 50,000*l.* a year. The staffing of the University has, in the past, been treated always as of first importance, and to this policy is largely due the substantial success it has achieved in the pursuit of its aims, but a situation has now been reached in which "its present efficiency is severely hampered and its future efficiency is imperilled both by the want of accommodation and by the unsuitability of much of the existing accommodation." In particular a new library building with accommodation for 200,000 volumes, new laboratories for the medical school, new buildings for nine or ten departments, new residential hostels; and a properly equipped students' union building are urgently needed. With the appeal, which is addressed especially to the local patriotism of Yorkshiremen, is circulated a booklet prepared for the jubilee celebrations of last year, giving an account of the growth of the University and a summary statement of its activities. The first list of subscriptions in reply to the appeal includes donations and promises amounting to more than 110,000*l.*

Early Science at Oxford.

October 24, 1683. Several members of the Royal Society and others, met at Oxford for making experiments. There was communicated an observation of the weight of the earth of the Nile about the time of the overflowing of that river, but especially a relenting of a piece of nitroon or nitre, brought from Ægypt, which continually wet the papers, on which it lay, both in rains and dry weather, from the middle of June till about the end of September.—There was also an intimation of fish having lived in a cistern upon rain-water only for half a year, till upon the freezing of the water they died by breaking of the ice.—There was also mention made of a probable way of tinging white marble black.

October 26, 1683. The Company meeting, in ye Naturall History School, desired Dr. Wallis, to take on him ye trouble of ye Chair; and appointed Mr. Musgrave, to take ye Minutes of their discourse; after which, Dr Plot made a learned Discourse on Earths. Upon ye account of the last branch of his Scheme, it was ordered by ye company, that some person should try, whether Boles burnt will apply to ye magnet? Dr. Plot was pleased to take this province on him: This gave occasion to a farther discourse concerning Magnetism; twas delivered as an observation, by Mr. Ballard, that a magnet, carried up, and down, in his pocket, has been found to attract sometimes more, then at other times.

'Twas ordered to be tryed, whether bricks, heated, and afterwards growing cold, in a posture North, and South, will acquire a verticity? Mr Ballard promised ye Society to try this experiment.

After this, an enquiry was made into ye nature, and reason, of striking fire; 'twas proposed as a quære? how tobacco-pipes (in which there is not ye least suspicion of a Sulphur) come to strike fire? 'Twas given in as an observation, that hardened iron (such as horse-shoes are made of) will yeild flakes of fire, larger, and of a deeper red, than steel will? This led ye Company to discourse of hardening Iron.

Dr. Plot was desired to give an account of ye methods used by ye smiths at Wolverhampton in these cases: 'Twas observed, that an ingenious smith of Oxford, us'd to soften his iron, by heating it moderately, then dawbing it over with tallow, and afterwards heating it red hot, and letting it cool gradually in the fire as that went out.

October 27, 1685. The Company being small no papers were read.

October 28, 1684. A bottle of water, sent the Society, by Mr. Maunder, from a well near Milton-Abby in Dorsetshire, was delivered in at our meeting by Mr. Crouch; and ordered to be examined as to its principles; which office Mr. Welstead took on him. The well from whence this water came, does sometime purge, sometimes vomit, and is said to cure ye gout.

Dr. Plot communicated an abstract of a letter dated from Minehead, October 17, 1684, in which Mr. Cole acquaints ye Doctor, that he was lately met with a shellfish on ye Severn shore, containing a white viscous phlegm, which being laid on cloth, turns greenish, within a minute or two; then being put out into ye Sun, for a little while, turns to a deep red, which grows somewhat lighter by ye first washing, but after that never decays, tho ye cloth be often washt. He adds farther, that this Tincture is extremely fetid, so that the ill smell is not easily taken away. He was pleas'd to send us Patterns of ye green, ye deep, and lighter Reds, which sufficiently answered their descriptions. The thanks of the Society were ordered to be returned him, for this considerable peice of newes.

Societies and Academies.

LONDON.

Royal Anthropological Institute, October 6.—Geza Roheim: Hungarian calendar customs. Three groups of customs connected with the calendar were discussed. In Hungarian winter dances a bull plays a conspicuous part. One of the performers may be called a bull, or the bull is a musical instrument used by these dancers. The identity of a demon and a musical instrument reminds us of primitive initiation ceremonies, and the Hungarian rites in question are actually connected with the initiation of lads. The fertility customs of St. George's day are based on the unconscious concept of birth, and it is in this sense that the Pahlia, the Roman prototype of St. George's day, was the birthday of the community. The kings and queens of Whitsuntide in Hungary show that these embodiments of fertility are really the survivals of primitive divine kings, for even in the seventeenth and eighteenth centuries, Hungarian Whitsuntide kings enjoyed certain privileges and wielded authority over the lads of their village for a year.

NAPLES

Academy of Physical and Mathematical Sciences.—Among the papers published in the issue of the *Rendiconti* of the Academy for April-August 1925, are the following: (1) Prof. R. Biazzo describes a modification of the thiocyanate method of determining the proportion of copper in commercial copper sulphate, in which the excess of thiocyanate used is ascertained by titration with permanganate in the presence of sulphuric acid. The iron present is previously eliminated by oxidation with chlorine and precipitation as ferric hydroxide, and, for the reduction of the copper to the cuprous state, potassium cyanide must be used in place of sulphurous acid. (2) Arnaldo Piutti is unable to find any relationship between the hafnium contents of samples of zircon from different localities and the densities of the minerals, but confirms von Hevesy's observation that a connexion exists between the proportion of hafnium present and the degree of radioactivity. (3) From the capacity of certain samarium minerals to form homogeneous mixed crystals with the corresponding compounds of calcium, strontium, and lead, Dr. G. Carobbi concludes that the isomorphism of samarium towards metals of the isomorphogenic calcium group is more pronounced than that exhibited by other metals of the cerium group. Such conclusion is in accord with the existence of the chloride, SmCl_2 , and the iodide, SmI_2 . (4) Antonio Carrelli extends to the phenomenon of diffusion of electromagnetic waves the method given by Lorentz for visible radiations and for X-rays, account being taken of the index of refraction, the existence of which Compton has demonstrated for such waves. In this manner he arrives at Rayleigh's classic formula for the coefficient of diffusion, and shows also that, in the case of X-rays, this formula coincides with that derived by Debye on the hypothesis that the wave-length of the radiations is not excessively small.

ROME

Royal Academy of the Lincei. Communications received during the vacation.—Achille Russo: A siderophilic substance emitted from the micro-nucleus of the impure garnets derived from the second division of the impure gametogens in *Cryptochilum echini*, and its destination.—Alfredo Sabbatini: Singularity of the solution of integral equations with variable limits.—Lubomir Tchacaloff: A general

property of differential equations (a theorem of Ernesto Pascal).—B. Caldonazzo: Movements of a liquid which leave unaltered the local distribution of the pressures.—E. Persico: Experiments on the amplitude of the oscillations produced by a three-electrode lamp.—Carlo Perrier: Method for the determination of the principal refractive indices of birefractive substances by means of Federow's plate.—Luigi Rolla and Giorgio Piccardi: Chemical statics of electronic phenomena. A simple method is outlined for the determination of the dissociation coefficient and the equilibrium constant of the reaction, $A \rightleftharpoons A^{++}$ electron.—G. Bargellini: β -Phenylcoumarins.—G. Bargellini and P. Leone: Glucosides of chalkones.—G. R. Levi and G. Natta: Crystalline structure of perowskite. Röntgenographic examination by the Debye-Scherrer method indicates for perowskite a face-centred cubic lattice, but the symmetry is only pseudo-cubic, the pseudo-cube being composed of the two rhombic forms (001) and (110). The apparently higher symmetry of the crystals is possibly the result of superposition of differently orientated lamellae.—R. Perotti: Root bacilli of *Diplotaxis erucoides*.—Roberto Savelli: A collateral effect, and a rapid method of study of the ionolysis of pollen.—P. Pasquini: Genesis of the pecten in the development of the eye in birds.—C. Jucci: Hereditary behaviour of the type of larval development in crosses between silkworms of three and four mutations.—Ettore Remotti: Embryonic metabolism of the Teleostei. The amino-acids derived from the degradation of the capsule and their relation to the embryo.—Mariannina Levi: The excitability of the retina in relation to the duration of the stimulus.

Official Publications Received.

Quaternary Climates. Geologic History of Lake Lahontan, by J. Claude Jones; On the Pleistocene History of the Great Basin, by Ernst Antevy; The Big Tree as a Climatic Measure, by Ernst Antevy; Tree Growth and Climatic Interpretations, by Ellsworth Huntington. (Publication No. 852.) Pp. 1+212+10 plates. (Washington: Carnegie Institution.)

Physiological Features of Roots, with Especial Reference to the Relation of Roots to Aeration of the Soil. By William Austin Cannon. With a Chapter on Differences between Nitrogen and Helium as Inert Gases in Anaerobic Experiments on Plants, by Edward Elway Free. (Publication No. 868.) Pp. iii+168. (Washington: Carnegie Institution.)

Ministerio de Agricultura de la Nación República Argentina. Memoria correspondiente al ejercicio de 1924. Dirección Meteorológica. Pp. 17. (Buenos Aires.)

Union of South Africa. Department of Agriculture. Bulletin No. 3 of 1925. Some Further Remarks on Tobacco Cultivation for Nicotine. By J. Verneil Cutler and J. J. Theron and J. du P. Oosthuizen. Pp. 28. (Pretoria: Government Printing and Stationery Office.) 3d.

S. A. Sugar Association. Proceedings of the Third Annual Congress held on March 25th, 26th and 27th, 1925, at Umbagogwin, Mount Edgecombe and Durban. Pp. 72. (Durban: South African Sugar Association.)

Proceedings of the Royal Irish Academy. Vol. 27, Section B, No. 6: The Brachyopoda of the Coasts of Ireland. By Anne L. Massey. Pp. 37-48. 1s. Vol. 27, Section B, Nos. 7, 8: The Action of Hydrazine on the Halogen Derivatives of Malonamides and Acetosuccinic Esters, by Dr. Edmund Langley Hirst, Dr. Alexander Killen Macbeth and David Traill; Condensation Reactions of Indoxyl and 8-Oxy (1) thionaphthyl, by Dr. Alexander Killen Macbeth and Dr. James Craik. Pp. 47-57. 1s. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Contributions to Palaeontology from the Carnegie Institution of Washington. Additions to the Tertiary History of the Plegma Mammals on the Pacific Coast of North America. By Remington Kellogg. (Publication No. 848.) Pp. iii+120+13 plates. (Washington: Carnegie Institution.)

History of Agriculture in the Northern United States, 1620-1860. By Dr. Percy Wells Bidwell and Prof. John I. Fiske. (Publication No. 854.) Pp. xii+812. (Washington: Carnegie Institution.)

The Volcanic Activity and Hot Springs of Lassen Peak. By Arthur L. Day and E. T. Allen. (Publication No. 860.) Pp. viii+100+13 plates. (Washington: Carnegie Institution.)

Reversible Variations in Volume, Pressure and Movements of Sap in Trees. By D. T. MacDougal. (Publication No. 865.) Pp. iii+60+5 plates. (Washington: Carnegie Institution.) 1 dollar.

Contributions to the Geology and Palaeontology of the West Indies. Miocene Mollusks from Bowden, Jamaica. Pelecypoda and Scaphopoda. By Wendell P. Woodring. (Publication No. 806.) Pp. vi+322+25 plates. (Washington: Carnegie Institution.)

Annual Report for the Year 1924 of the South African Institute for Medical Research, Johannesburg. Pp. 81+2 plates. (Johannesburg.)

British Museum (Natural History). British Birds. Residents. Series No. 1, Set C15. 5 cards in colour 1s. Series No. 2, Set C16. 5 cards in colour. 1s. Coloured cards not included in any Set. Mammals, B91-B97. 2d. each. Birds, C96-C97. 2d. each. (London: British Museum (Natural History).)

Tables annuelles de constantes et données numériques de chimie, de physique et de technologie. Publiées sous le patronage du Conseil International des Recherches (Bruxelles 1922) et de l'Union Internationale de la Chimie pure et appliquée (Rome 1920) par le Comité International institué par le VII^e Congrès de Chimie appliquée (Londres 1909). Rapport général présenté au nom de la Commission permanente du Comité International pour l'année 1924. General Report presented in the name of the Permanent Commission of the International Committee for the Year 1924. Pp. 22 (Paris 6s.).

The Botanical Society and Exchange Club of the British Isles. Vol. 7, Part 3: Report for 1924. By G. Claridge Druce. Pp. 415-702. (Aldroth: T. Buncle and Co.) 10s.

Ministère de l'Instruction publique et des Beaux-arts. Enquêtes et documents relatifs à l'enseignement supérieur. 120. Rapports sur les Observatoires astronomiques de Province, année 1924. Pp. 99. (Paris: Imprimerie Nationale.)

University of London: University College. Calendar, Session 1925-1926. Pp. clxxviii+104+458+34. (London: Taylor and Francis.)

Fifth Annual Report of the Scientific and Industrial Research Council of Alberta, 1924. (Report No. 12.) Pp. 67. (Edmonton, Alta.: J. W. Jeffery.) 35 cents.

University of California Publications in American Archaeology and Ethnology. Vol. 21, No. 4: The Uhlo Pottery Collections from Ancon. By William Duncan Strong. Pp. 136-190+plates 41-49. (Berkeley: University of California Press; London: Cambridge University Press.) 90 cents.

Journal of the Indian Institute of Science. Vol. 8A, Part 12: (1) An Examination of some Gum-Enzymes, by Gilbert J. Fowler and M. A. Malandkar; (2) Chemical Constitution of the Gum from "Boswellia serrata," by M. A. Malandkar. Pp. 221-243 (Bangalore) 1-rupee.

Report of the Council of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne, intended to be Presented at the Annual Meeting of the Society, 19th October 1925. Pp. 42. (Newcastle-upon-Tyne.)

Astrophographic Catalogue, 1900 O. Sydney Section, Dec. -51° to -65°. From Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 1: R.A. 0h to 6h, Dec. -51° to -53°, Plate Centres Dec. -52°. Pp. 25. Vol. 2: R.A. 6h to 12h, Dec. -51° to -53°, Plate Centres Dec. -52°. Pp. 85. (Sydney: Alfred James Kent.)

Advisory Committee for Aeronautics. Reports and Memoranda, No. 425: Model Drogue Experiments. By G. S. Baker. (A.S.k. Model Experiments—Misc., 14.) Pp. 12+8 plates. (London: H.M. Stationery Office.) 9d. net.

Aeronautical Research Committee, No. 974 (M.29): Report on the Use of Artificial Sources of Light as a Substitute in the Weathering of Fabric, Part I. By W. G. Glendinning. (B.I.c. Fabrics-Aeroplanes, 61—T 1931, revd.) Pp. 5+1 plate. (London: H.M. Stationery Office.) 6d. net.

Diary of Societies.

SATURDAY, OCTOBER 24.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District) (at Bridgwater), at 11.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 8.30.—A. M. Hedley: Presidential Inaugural Address.—H. T. Foster: Rescue Work in Mines.—Discussion upon Papers by P. S. Lea on A Few Notes on the "Safety First" Movement, and W. McLaren, O. N. Kemp, and J. L. Thomson on The Scientific Control of Coal-Washing by the Combined Application of Ash Characteristic Curves and X-Ray Examination.

BRITISH PSYCHOLOGICAL SOCIETY (at King's College), at 3.15.—B. Stevanovic: Conational Phenomena in Processes of Judgment.—Miss Ethel Stoneman: Apparatus used to investigate Electrical Changes accompanying Emotional States in the Insane. The Waller Emotometer and the Godefroy Tachogram.

MONDAY, OCTOBER 26.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Mr. Shattock: Demonstration of Cysts.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—R. A. Chattock and others: Discussion on How can the Cost of Distribution be Cheapened?

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—R. W. Gregory: Chairman's Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—H. K. Thomas: The Automobile Engineer (Presidential Address).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—J. L. Payne: Presidential Address.—A. T. Pitts and J. H. Mumery: A Melanotic Epithelial Odontome in a Child.

MEDICAL SOCIETY OF LONDON, at 8.30.—Clinical Evening.

INSTITUTE OF CHEMISTRY (Manchester and District Section) (Annual General Meeting, at Manchester)—F. Scholefield: Account of the Discussion on the Registration of Chemists, at the York Conference.

TUESDAY, OCTOBER 27.

ROYAL SOCIETY OF MEDICINE (Medicine Section) (at Middlesex Hospital), at 5.30.—Clinical Meeting.

INSTITUTION OF AERONAUTICAL ENGINEERS (at Junior Institution of Engineers), at 6.30.—Dr. A. P. Thurston: The International Aircraft Navigation Congress.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at the College, Loughborough), at 6.45.—H. D. Symonds: Insulation.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at 83 Pall Mall), at 7.—Discussion on Petrol Gauges.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—T. W. Ridley: Railways.

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 8.15.—S. M. Edwards: The Population of the City of Bombay: A Few Facts concerning its Origin and Growth.

ROYAL SOCIETY OF MEDICINE, at 9.30.—Sir St. Clair Thomson: Shakespeare as a Guide in the Art and Practice of Medicine.

WEDNESDAY, OCTOBER 28.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section), at 5.—F. T. G. Hobday: Presidential Address.—Dr. W. H. Andrews: Some Recent Advances in our Knowledge of Plant Poisoning, followed by a discussion.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Centre) (at 244 Deansgate, Manchester), at 6.30.—H. K. Thomas: The Automobile Engineer (Presidential Address).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.—Chairman's Address.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (at Armstrong College), at 7.30.—Prof. H. V. A. Briscoe: The Phenomena of Intensive Drying and their Significance.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications of the Microscope Section), at 7.30.—Dr. F. J. Brislée: Dark-Ground Illumination for the Examination of Textile Fibres.—J. P. Strachan: The Microscopical Structure of Paper making Fibres in Relationship to their Manufacturing Properties.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (jointly with the Psychiatry Section of the Royal Society of Medicine) (at 1 Wimpole Street), at 8.30.—Symposium on The Early Treatment of Mental Disorders.—For the Royal Society of Medicine, Psychiatry Section: Sir Maurice Craig; for the British Psychological Society, Medical Section: Dr. W. Brown.

THURSDAY, OCTOBER 29.

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street), at 5.30.—W. L. Cowley: Aircraft Transport Economy.

INSTITUTION OF CIVIL ENGINEERS (jointly with Institution of Mechanical Engineers, Institution of Electrical Engineers, Institution of Naval Architects, Institute of Marine Engineers, North-East Coast Institution of Engineers and Shipbuilders, Institution of Engineers and Shipbuilders in Scotland, Institute of Chemistry of Great Britain and Ireland, Institution of Gas Engineers, British Electrical and Allied Manufacturers' Association, British Engineers' Association, Admiralty, War Office, and Air Ministry), at 6.—G. J. Wells: Standard Codes for Tabulating the Results of Trials of Gas-Engines and Gas-Producers.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Marjorie Gullian: The Teaching of Poetry.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Engineers' Club, Coventry Street), at 7.—R. W. Reid: Presidential Address.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—R. H. J. Swan: Some Reflections upon Villous-covered Tumours of the Bladder (Presidential Address).

INSTITUTE OF CHEMISTRY (Glasgow Section) (at Glasgow).—Annual General Meeting.

FRIDAY, OCTOBER 30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Preparations and Dissections to illustrate the Evolution of the Human Mechanism of Hearing.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—L. Pendred and others: Discussion on Recent Locomotive Progress at Home and Abroad.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—The Construction and Assembly of 50,000 K.W. Turbo-alternator Plant for Chicago at the Works of Messrs. C. A. Parsons and Co., Ltd. (Kinematograph Lecture).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—G. Jervis: Manufacture of Coal By-products.

DENTAL BOARD OF THE UNITED KINGDOM (at Royal Society of Medicine), at 8.30.—Prof. L. Hill: Circulatory Changes in Anesthesia, and the Use of Oxygen.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

PUBLIC LECTURES.

SATURDAY, OCTOBER 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milhigan: The Defences of Animals.

MONDAY, OCTOBER 26.

KING'S COLLEGE, at 5.30.—Rev. Dr. F. A. P. Aveling: Psychology and Industry.

WEDNESDAY, OCTOBER 28.

UNIVERSITY COLLEGE, at 5.30.—Viscount Grey of Fallodon: The Open Air Sanctuaries of the National Trust.—At 5.30.—Dr. E. A. Baker: The Use of Reference Books.

THURSDAY, OCTOBER 29.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—H. Peake: Cave Art and some Modern Counterparts.

KING'S COLLEGE, at 5.30.—Prof. T. P. Nunn: The Influence of Education and Tradition in Social Hygiene.

UNIVERSITY COLLEGE, at 5.30.—Prof. E. G. Gardner: Italian Universities in the Middle Ages.

SATURDAY, OCTOBER 31.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—C. D. Forde: Stone Age Man in Brittany.



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Research in Engineering.

ENGINEERING research may be said to have had its birth in the investigations of Smeaton on wind and water power and in the work of Watt on the steam-engine. Almost contemporary with their investigations we see in France the application of mathematical science to the forms and masting of ships, and the establishments of the École des Ponts et Chaussées and the École des Mines, the former having for its director the distinguished civil engineer Perronet. These various activities were among the firstfruits of the extension and application of the experimental sciences, and ever since there have been men, in increasing numbers, who have concerned themselves with the scientific principles underlying the work of the engineer and the adaptation of scientific discoveries for everyday needs. There can be no question that material progress in the past half-century has been principally due to this co-operation of science and industry, and it is in this direction hopes for the future lie. Huxley many years ago wrote: "As industry becomes more complicated and competition more keen, the sciences are dragged in one by one to take their part in the fray, and he who can best avail himself of their help is the man who will come out uppermost in the struggle for existence."

At first engineering research was but a sluggish stream confined within narrow channels, but with the coming of the steamship and the railway and all the great works they included, the sluggish stream was quickened into life, and it has now become a mighty river having tributaries in every branch of practical work. Watt, Smeaton, Perronet, and Réaumur were followed by Rennie, Barlow, Tredgold, and Navier, who in turn were succeeded by Carnot, Clapeyron, Wohler, Tresca, Bauschinger, Froude, Hirn, and Rankine, whose names are known to every student and whose labours are the heritage of the engineering world. Then, too, institutions for mechanics, such as the Andersonian at Glasgow, paved the way for our technical schools and colleges, the leaders of engineering formed themselves into societies for the discussion of both theory and practice, engineering professorships and engineering laboratories were founded, organisations such as the British Association fostered research in engineering, eminent captains of industry invited the assistance of chemists and physicists in their undertakings. State departments also initiated original investigations, and governments, convinced by the ever-accumulating mass of evidence of the importance of research, established institutions such as our own National Physical Laboratory, while another landmark was passed when in 1915 the British Government created a new public office under the title of the Department of Scientific and

Industrial Research, which already has a budget of nearly half a million.

The total amount of research carried out in engineering all over the world to-day can best be gauged by a review of the innumerable periodicals and journals, the transactions of the engineering societies, blue books and reports, of which there is a never-ending succession. But in spite of this, just as the Romans called for roads and still more roads, so the insistent demand to-day is for research and still more research. Its methods, its scope, and its results are referred to in practically every presidential address, and the foremost engineering institutions make its energetic pursuit a part of their programme. Of recent addresses referring to this topic, mention may be made of the presidential address of Engineer Admiral Sir George Goodwin to the Institution of Engineers-in-Charge, of the autumn lecture to the Institute of Metals by Sir John Dewrance, the president-elect, and of the address of Mr. H. Kerr Thomas to the Institution of Automobile Engineers.

Mr. Thomas regards the automobile engineer as a man who adapts the ideas of the inventor and the theories of the man of science to the needs of the public. Just as it is essential for him to organise his factory, so he should organise both inventor and scientific investigator for the benefit of the community. Many automobile engineers have failed to do this; and Mr. Thomas gives it as his considered opinion that if the automobile engineer has been careless of the money of his patron, and occasionally has been apathetic towards the inventor, his attitude towards the man of science has been simply inexplicable. "I will go further," Mr. Thomas continued, "and say that if this attitude does not alter, and that speedily, although the statement may sound exaggerated, it is my belief that this industry, one of the largest in the country, will be found to have passed its zenith, and will more or less rapidly decline until it is faced with extinction."

Dealing with the questions as to who should carry out the research, and how to obtain the fullest value, Mr. Thomas declared that the whole training of the automobile engineer, whose work consists of manufacturing something to be sold, unfits him for the work of research. "It is no more possible for him to do his own research work than it is for him to make the tracings in his drawing office, or to operate his capstan lathes." But it is needful for him to organise the work of the research laboratory, and this implies the capacity of working with other people, "for in government laboratories, universities, and technical colleges all over the world, there are men concentrating on just the problems which daily confront the automobile engineer." Co-operation with other manufacturers is necessary also, for the old plan of secrecy is in the end impracticable, and it is happily

coming to be regarded as more advantageous in the end to give away information than to withhold it.

In his final paragraphs, Mr. Thomas refers to the cost of research. Since 1920 there has been a Research Association under the Association of British Motor and Allied Manufacturers. The funds were provided by the motor industry, which disburses in wages some 30,000,000*l.* a year. But only about $\frac{1}{100}$ th of 1 per cent. of this sum was set aside for communal research. If but $\frac{1}{10}$ th of 1 per cent. were set aside, there would be a fund of 30,000*l.*, which, together with the help from the Department of Scientific and Industrial Research, would enable work to be attempted on a scale hitherto unknown. The American engineering institutions have formed an Engineering Foundation, a trust in which all participate. It has invested already 550,000 dollars, and now there is a serious proposal put forward by the president of the American Institution of Electrical Engineers to provide a community fund of 20,000,000 dollars. Engineering research should not be carried out in watertight compartments, and it is plain that if Great Britain were to pool its research the greatest economy could be achieved, but, says Mr. Thomas, "it would be necessary for the automobile engineers to accord to the joint research body their whole-hearted support."

The general recognition of the value of research in engineering has come about during the last thirty years. In the first James Forrest lecture to the Institution of Civil Engineers in 1893, Anderson, having for his subject "The Interdependence of Abstract Science and Engineering," remarked: "It seems to be the fate of peoples to attack social problems from the wrong end, to solve them by the painful and dilatory process of trial and error, rather than by means of investigations based on first principles, and this method is commonly applied to engineering problems. Random trials, as a rule, are the methods by which great results have been achieved, while the application of the scientific principles involved has been left to other heads, long after the results have been attained at much needless cost and by much unnecessary expenditure of labour and of time." These words were uttered when the motor industry was still in its cradle. Rolls did not import his first motor-car into England until 1895, and nearly ten years passed before Henry Ford offered his first car to the public. No one then dreamt that thirty years later the world would possess 20,000,000 motor vehicles or that a single factory would be able to turn out 8000 motor-cars a day. But such are the achievements of to-day, and they have been rendered possible only by the close co-operation of the chemist, the physicist, and the metallurgist, with the skilled engineer and the business man.

Greek Myths and Mycenaean Realities.

The Ring of Nestor: a Glimpse into the Minoan After-World and a Sepulchral Treasure of Gold Signet-Rings and Bead-Seals from Thisbe, Boeotia. By Sir Arthur Evans. Pp. ii + 75 + 5 plates. (London: Macmillan and Co., Ltd., 1925.) 12s. 6d. net.

TO-DAY even the most old-fashioned admirer of Hellenism has to admit that classical Greek civilisation was not only preceded by but also actually rooted in the Minoan culture of Crete and its continental daughter, the Mycenaean. The excavator of Minos' palace at Knossos, who so dramatically found the key to the riddle of pre-classical Greece, has himself taken the lead in tracing the influence of the Minoan civilisation on the classical; again and again he has illuminated the dark background of Hellenic life by a reference to the remains of the prehistoric age or interpreted the monuments of that still dumb epoch from the records of historic Greece.

Fresh evidence pointing in the same direction is presented in the monograph before us. Its first section describes thirteen gold seals allegedly found together in a Mycenaean tomb near Thisbe in Boeotia. Some of the seals are engraved with religious subjects and serve to extend the already large series of Minoan prototypes for classical rites and Minoan deities in the Greek pantheon. The scene of a goddess rising from the earth on Seal 6 comes startlingly close to later representations of the *anodos* of Kore. Yet there is really nothing surprising in this; Persephone (Pherséphassa) has a "pre-Hellenic" name, her "mother" came from Crete, her cult-centre at Eleusis is the site of a Mycenaean village. Those commentators who see in Persephone a corn-maiden should observe that the goddess on the seal holds poppies in her hands, a feature paralleled later in the art of Magna Grecia. Another novel suggestion is that the two girl attendants of the Minoan goddess who figure on Seal 5, as on other Minoan gems, are in a sense forerunners of the Dioscuri. Sir Arthur Evans, however, unlike Dr. Farnell, admits that the Heavenly Twins were Aryan deities, blood-brothers of the Vedic *divo napātā*, and supposes that they had assimilated the pre-Hellenic figures, as happened in other cases.

It was, however, above all through the Homeric epics and heroic saga that the Mycenaean age lived on into the classical. The centres of the great cycles of heroic myth—Mycenae, Thebes, Tiryns, Iolkos, Kalydon—are precisely the centres of Mycenaean culture, as Prof. Nilsson has recently shown. The correspondence between the heroic and the Mycenaean geography of Greece is, indeed, so exact that a study of the legends enables us to locate in advance the prehistoric sites;

it was thus that Dörpfeldt was led to the discovery of the rich tombs of Kakovatos, the half-forgotten site of Nestor's capital. Ever since Dr. Schliemann's first discoveries, the Mycenaean objects have been used with conspicuous success to illustrate Homeric descriptions of houses, works of art, weapons and methods of fighting, though other passages in the poems seem to reflect a different environment. Finally, names celebrated in Homer, Achaeans and even Atreus himself (if Dr. Forrer's interpretation of a tablet from Boghaz Keui be correct), have been discovered in historical Hittite and Egyptian texts. Such discoveries have naturally invested the old "Homeric question" with a new significance and revolutionised our view of the Heroic Age; the towns and figures of saga are becoming historical, the splendours of the epic concrete realities. Three seals from Thisbe are now presented as marking a quite new and decisive step in linking up the Mycenaean age with the Heroic and so with the Classical; they seem to imply that some of the legends at least existed, in very much the form that has come down to us, so early as the fifteenth century B.C. Two intaglios represent concrete episodes from the Oedipus cycle—the hero's encounter with the Sphinx and the killing of Laius in the Hollow Way. The third is interpreted as depicting the vengeance of Orestes on his guilty mother and her paramour, Aegisthos.

Hence some of the material used by the epic poets would have existed in saga form by the fifteenth century B.C., when the Thisbe seals are said to have been engraved. This evidence, if it be accepted, would have a decisive bearing on the whole Homeric controversy; it would afford brilliant confirmation for the theory of a "Minoan epos," already suggested by Sir Arthur Evans in 1912 to account for the Mycenaean traits in Homer; and this Minoan epos might easily be identified with the "Heroic Chronicle" inferred by T. W. Allen from the literary data as the source from which "Homer" drew much of his material.

Now if a body of saga really existed in a form from which later rhapsodes could borrow descriptions of actual works of art—our author cites Nestor's cup as an example—and embodied accounts of historical events, like the death of Aegisthos, which were "transferred" to a different context, the attractive theory of an "Achaean period" at the end of the Mycenaean becomes superfluous. Commentators have identified the epoch of Achaean domination described in the Iliad with the archaeological period known as Late Mycenaean B, when, after 1250 B.C., "Homeric" innovations—cremation, iron, slashing swords and breast-plates—begin to appear within the framework of Mycenaean culture, just in order to reconcile the Mycenaean and un-Mycenaean aspects of Homeric life; the contem-

porary Hittite and Egyptian references to Achæans—in Asia Minor and Libya—are merely invoked incidentally as confirmatory evidence. The “nameless Mycenæans” would be the Achæans of Homer, the un-Mycenæan traits in the present poems anachronisms introduced by the later minstrels who used the older saga.

It is true that the Heroes would not then be Greeks. Sir Arthur Evans in this volume again insists that the Mycenæan civilisation was implanted in Greece by actual conquerors come from Crete, and even invokes the Keftian word *Akashau*, found in an Egyptian school-book, to prove that Aegisthos at least was a Minoan. At the same time their subjects may, he admits, have included Greeks. It would then be easy to comprehend how such civilising conquerors became Hellenised in the imaginations of their Greek subjects and were appropriated by later generations as national heroes. Such, we submit, is the only logical conclusion to be drawn from the theory of a Minoan epos, though its author does not go so far, but seems still to adhere to the theory of an “Achæan period,” two or three centuries later than the Thisbe seals or the episodes they depict.

It is only fair to warn the reader, however, that the evidence of the seals cannot yet be accepted as conclusive; for their authenticity is still in dispute. Their owner can, indeed, add to his own authoritative opinion in their favour the judgment of two other experts. He further points out that two seals in the “same” group exhibit peculiarities in design, now paralleled on other indisputably genuine documents which could not have been known to a forger when the Thisbe treasure came to light. Finally, the existence of Mycenæan tombs near Thisbe is established. Nevertheless, the circumstances in which the jewels were discovered are shrouded in mystery. The treatment of the whole group as a unit rests on the subjective estimation of technical criteria; and it is precisely technical peculiarities in some of the seals, notably the three depicting heroic themes, that give rise to uneasiness. The unpleasant possibility must be borne in mind that a forger added these more striking specimens to a group of genuine but rather commonplace gems. That does not, of course, detract in the least from the enormous value of Sir Arthur’s commentary on the scenes, the masterly account of the evolution of the chariot, for example.

Fortunately no such suspicions attach to the unique gold ring which gives its title to this monograph. It is undoubtedly a remnant of the regal wealth once buried in the great tombs of Kakovatos, which had been plundered long before the Germans excavated them scientifically. The elaborate scenes engraved on this unique signet are interpreted by its present owner with

his usual penetrating insight and perfect mastery of comparative mythology. But the world of ideas thus revealed is quite un-Homeric. We see the World Tree and its canine guardian, prototype of Cerberus. From other details Sir Arthur is able to deduce that the Mycenæans conceived souls as butterflies and the chrysalis as a symbol of resurrection. With the aid of this idea, several curious objects from the shaft graves of Mycenæ can be explained, and the miniature balance comes to suggest the idea of a weighing of souls.

The author considers that the ring, like others from Minoan and Mycenæan funerary deposits, belongs to a special sepulchral type of signet, designed for suspension and not worn on the finger, the origin of which he finds in an ivory specimen from an Early Minoan tomb in Crete. It is true that the inner diameter of the hoop—14.5 mm.—seems too small for the finger of an adult. Nevertheless, the bosses adorning the hoop have been rubbed down a little, just as they would have been by actual wear on the finger, a point which is not noted in the publication.

V. GORDON CHILDE.

The Isle of Mull.

(1) *Memoirs of the Geological Survey, Scotland. Tertiary and Post-Tertiary Geology of Mull, Loch Aline, and Oban. (A Description of Parts of Sheets 43, 44, 51, and 52 of the Geological Map.)* By E. B. Bailey, Dr. C. T. Clough, W. B. Wright, J. E. Richey, and G. V. Wilson; with Contributions by E. M. Anderson, H. B. Maufe, Dr. G. W. Lee, B. Lightfoot, Dr. T. O. Bosworth, and G. A. Burnett; with Petrology by Dr. H. H. Thomas and E. B. Bailey; with Chemical Analyses by E. G. Radley and F. R. Ennos; and Palæobotany by Dr. A. C. Seward and R. E. Holtum. Pp. v+445+6 plates. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1924.) 15s. net.

(2) *Memoirs of the Geological Survey, Scotland. The Pre-Tertiary Geology of Mull, Loch Aline, and Oban. (Being a Description of Parts of Sheets 35, 43, 44, 45, and 52 of the One-inch Geological Map of Scotland.)* By Dr. G. W. Lee and E. B. Bailey; with Contributions by S. S. Buckman and Dr. H. H. Thomas. Pp. iv+140+2 plates. (Southampton: Ordnance Survey Office; London: Edward Stanford, Ltd., 1925.) 4s. 6d. net.

(1) **T**HE larger of these two memoirs, that on the Tertiary geology of Mull, represents the results of work commenced by the Geological Survey in 1907. The title-page includes the names of five principal authors and of eleven other contributors. The task of the principal author and editor can have

been no easy one, and one is prepared for the complexities of the memoir by the opening words of the introduction: "It may safely be maintained that Mull includes the most complicated igneous centre as yet accorded detailed examination anywhere in the world." The reader should study the plan of the memoir in the opening chapter and refer to this again and again as he reads the successive chapters in which the intricate history of the island unfolds itself. The map which accompanies the memoir is a most complicated piece of detailed work, in which no less than 74 different symbols are employed. Its interpretation is greatly assisted by the provision of plates in the body of the memoir showing simplified maps, in black-and-white, of the various stages of the igneous cycle.

Those geologists who are fortunate enough to visit the island will welcome the "Itinerary" in Chap. i, and the wealth of detail in succeeding chapters which indicate where important sections can be seen. The second chapter, which gives a critical survey of geological research in Mull, will be read with great interest. There have been many controversies over the geology of the district, and the memoir brings new light to bear on them. Subjects of outstanding interest are: the type of volcanic activity prevailing in Mull, the causes of double-tier columnar jointing, and the distinctions between intrusive sills and lava-flows.

There are also many new conceptions, some of which cannot fail to find a place in the interpretation of other volcanic centres. The "propylite-area" of Judd is shown to be an area of pneumatolysis about a volcanic centre, within which the degree of freshness of the rocks and the type of weathering are profoundly affected. The "inclined-sheets" described by Dr. Harker in Skye are represented here by "cone-sheets," intrusive sheets, very numerous and of considerable thickness in the aggregate, which, viewed as a whole, "suggest the partial infilling of a number of cone-shaped fractures with inverted apices united underground." The intrusion of a series of cone-sheets characterises the second cycle of igneous activity in Mull following the formation of a Kilauean lava-dome with a central caldera some five miles in diameter.

Another mode of igneous intrusion which is wonderfully illustrated in the later stages of the volcanic history of the island is that of the ring-dikes. Few of these present complete ring-outcrops, but the Loch Bà felsite forms an almost complete ring, and follows a ring-fracture which outlines an area of subsidence similar to the first-formed caldera, but centred about a new focus which was the seat of the later phases of igneous action.

The various chapters on petrology contain contributions of the first importance. The sequence of igneous

intrusions is explained on the assumption of at least two magmatic cycles, in both of which the magma-sequence is from basic to acid, followed by a third intrusion of the parental basic magma as a swarm of north-west to south-east dikes, which are the last evidences of igneous activity left by subsequent denudation. The authors' explanation of the magma-sequence is briefly outlined in the opening chapter. Important evidence of gravitational differentiation is obtained from the ring-dike of Glen More, which is exposed for a height of about 1500 feet and shows a gradual transition from basic quartz-gabbro at the bottom to acid granophyre at the top.

The results of the careful study of very interesting sapphire-bearing aluminous xenoliths in the Loch Scridain sills has been the subject of a paper elsewhere, but the summary of the results given here will be none the less welcome. Only one new rock name—Craig-nurite—is introduced, but there is fresh information on little-known rocks described by two of the contributors to the memoir, and some welcome definitions of other names which have been widely used in British Survey nomenclature.

The only sedimentary rocks of Tertiary age in Mull appear below the lavas or very low down in the volcanic sequence. Fossils from the well-known plant-beds of Ardtun are described by Prof. Seward and Mr. Holtum, who confirm Mr. J. S. Gardiner's conclusion of their Eocene age and show that they are related to the Lower Tertiary flora of Greenland and other Arctic regions.

The last five chapters deal with the post-igneous history of the island, pre-Glacial, Glacial, and post-Glacial, and with its economic geology, the last amounting to nothing more than adequate supplies of good road-metal inconveniently situated for shipping, and some seams of Tertiary lignite of rather poor quality.

(2) The smaller of the two memoirs describes the pre-Tertiary rocks of Mull and other areas on Sheet 44 and adjacent sheets which have escaped denudation or have not been buried by the volcanic accumulations. Several interesting points may be mentioned. In the account of the Ross of Mull granite, particular attention has been paid to its contact metamorphism, and something is added to Dr. T. O. Bosworth's earlier account of this. A small patch of Carboniferous rocks on the mainland near Inninmore is of especial interest, as only two other occurrences are known in the Western Highlands. Rhætic beds containing the *Pteria contorta* fauna are described from the Gribun district: they are not known *in situ* elsewhere in Scotland. The Inferior Oolite is much thinner than in Skye; it shows close resemblances to the succession of rocks of the same age in the classical districts of England.

The Cretaceous rocks include the only known occurrence *in situ* of Upper Cretaceous rocks in Scotland. In the White Sandstone, which lies below the Chalk, the "millet-seed" character of some of the sands is regarded as evidence of desert conditions on the shores of the Cretaceous sea.

The final chapter on the economic geology includes an account of the building stone quarried in the very decorative Ross of Mull granite, and a record of a good glass-sand at Loch Aline, on the mainland.

Chemical Problems of Soil Fertility.

Base Exchange in Soils: a General Discussion held by the Faraday Society, December 1924. Pp. 547-617. (London: The Faraday Society, 1925.) 5s. net.

ONE of the directions in which little real progress has been made in agricultural science, in spite of an immense amount of careful work, is in the exact specification of soil fertility by means of chemical analyses. Such analyses have, in general, only qualitative significance, and their main purpose is to serve as a check to the direct field observations. In recent years considerable progress has been made, however, especially by American workers, who have paid especial attention to the concentration of radicles in the so-called "soil-solution." Progress in such a complex problem as the fertility of a normal soil is most likely to be made if extreme cases are taken, such as alkali and acid soils, where certain factors are thrown into high relief. The work of Kelly and others in California, on alkali soils, and of Bradfield in Missouri on acid colloidal clay, are good illustrations of the method. More recently Dr. Hissink and his collaborators at Groningen, Holland, have effectively used the well-known electrical double layer hypothesis as the basis of a reasonably complete theory of base exchange that can be applied to a wide range of soil conditions: the exchangeable bases are held on the surface of the clay particles by chemical attraction between them and the clay and humus acids. In a suspension of soil in water, some of the surface molecules are ionised, and an electrical double layer is formed, containing anions of soil acids inside, and outside the cations H' , Mg'' , Ca'' , K' , Na' . Students of soil science will recognise in this hypothesis a restatement in modern terminology of the essential features of Way's classic investigations of 1850.

Dr. Hissink, in his introductory paper, considers both the degree of saturation of the soil (which is the ratio of the quantity of adsorbed bases actually present, to the total amount the soil could hold) and the relative proportions of exchangeable bivalent and univalent bases. The relation of these factors to soil properties such as physical condition and pH value is discussed

in detail, and with special reference to Dutch land-reclamation problems. Messrs. Page and Williams present some important studies of base exchange in the classical Broadbalk permanent wheat and Park grass plots at Rothamsted. The long-continued treatment of these plots with various artificial manures would be expected to accentuate many of the base exchange processes, and thus to provide yet another illustration of the incomparable value to agricultural science of long-time experiments. The results show that on the acid soil of the grass plots from which chalk is absent, the amount of exchangeable calcium is correlated with the pH of the soil. On Broadbalk, where considerable quantities of chalk still remain, the relative proportions of the different bases vary consistently with the manuring, and there is some evidence of a gradual conversion of exchangeable potash to a non-exchangeable form or vice versa depending on whether potash manures are used or not.

The value of the base exchange theory in suggesting not only new view-points of known facts, but also fresh lines of work, is well shown by the remaining papers. Prof. Comber reviews earlier work based on the physical adsorption hypothesis and has some cogent observations to make on the part played by electro-negative ions. Messrs. Robinson and Williams, of Bangor, in a study of some Welsh soils subject to high rainfall, show that their lack of response to liming, although they appear "acid" by lime requirement tests, is due to the presence of considerable proportions of exchangeable calcium as determined by Dr. Hissink's method. These soils are "acid" in the chemical sense but not "sour" in the agricultural sense. Mr. E. A. Fisher contributes two suggestive papers on the relation of base exchange to adsorption phenomena, and the swelling of soil colloids. Mr. Saint, working in Prof. Comber's laboratory, shows that there is no consistent relation between the pH value, the "lime-requirement" and the Comber thiocyanate test of acidity for soils of different types.

The verbatim report of the discussion is at least as interesting as the papers, and there is much healthy criticism of both methods and results. Attention should be directed to Dr. T. P. Hilditch's discussion of industrial developments of synthetic aluminosilicates for water-softening purposes and the close relation of this to base exchange in soils.

This is the third general discussion on agricultural problems that the Faraday Society has held since 1920. The value of these discussions and the demand for the reports is shown by the fact that the accounts of the first two meetings are now out of print. The high level of the present discussion and its modest price will certainly ensure an equally gratifying demand for copies.

B. A. KEEN.

Our Bookshelf.

The Flora of the Malay Peninsula. By Henry N. Ridley (Published under the Authority of the Government of the Straits Settlements and Federated Malay States.) Vol. V. Monocotyledones (concluded), Gymnospermæ, General Indices.- Pp. v + 470. (London: L. Reeve and Co., Ltd., 1925.) 42s. net.

VOL. V. of this "Flora of the Malay Peninsula" deals with the remainder of the Monocotyledons, and with the Gnetaceæ, Coniferæ, and Cycadaceæ. Seven new species and specific names occur in the Palmaceæ, three in the Pandanaceæ, four in the Aroidæ, two in the Eriocaulaceæ, five in the Cyperaceæ, and thirty-nine in the Gramineæ. In this latter family many of the additions are from the manuscript of Dr. O. Stapf. In the Coniferæ the only new species is *Podocarpus deflexus* from high altitudes on Gunung Tahan.

Bound with this volume is a supplement in which is described material which has reached the author since the publication of the respective volumes dealing with the natural families to which the species belong. This occupies fifty-seven pages and includes several new species. The author also gives a brief discussion on the origin of Malay plant names. The remainder of the volume contains four general indices to the whole work; an index to English plant names, and what will be found particularly valuable, an index to Malay plant names; an index to the two hundred and twenty-eight illustrations, and an index to botanical names.

This "Flora," which is completed with the present volume, is one of the most outstanding accomplishments among floras of this magnitude. The author, after many years' residence in the tropics, during which he collected much of the material described, has not only worked over the whole of the specimens and written the manuscripts, but, unaided, has also supervised the entire publication. The general preparation of the work was well in hand before publication, and this has enabled the whole of the five volumes to be produced within a period of only four years, during a part of which the author was prevented from active work by illness. He has been fortunate in securing the services of Mr. J. Hutchinson for the illustrations, which are a distinctive feature of the work, and provide a welcome innovation in colonial floras. Mr. Ridley must be congratulated on having completed and produced during the first few years of his retirement a work of such first importance.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. 30: *Copper Ores of the Midlands, Wales, the Lake District and the Isle of Man.* By Henry Dewey and T. Eastwood; with Contributions by Dr. Bernard Smith and R. G. Carruthers. Pp. v + 87 + 6 plates. (London: H.M. Stationery Office; Southampton: Ordnance Survey Office, 1925.) 2s. net.

THIS memoir deals with a large number of occurrences of copper ores outside Devon and Cornwall, which, although now of very limited economic importance, are nevertheless of considerable scientific interest because of the great variety of modes of occurrence which they present.

On this basis the ore-bodies are divided into (1) impregnations of the country rock, (2) lodes, and (3)

pipes and other irregularly shaped bodies. The first type includes the ores forming a cement in certain Triassic rocks in Cheshire and elsewhere. The curious occurrence at the Turf Mine, Dolfrwynog, in Merionethshire, where wood, leaves, and hazel-nuts lying at the base of a peat-bog were either coated or impregnated with copper or its ores, appears also to afford an interesting case of impregnation which might throw some light on the formation of the Triassic ores. It is, however, somewhat illogically discussed under the third category. The Ecton Mine in Staffordshire, belonging to the latter type, contained an irregular pipe-like mass of ore which has been worked to a depth of 225 fathoms below the surface.

The period of mineralisation is not known with certainty, but is suggested to be the same as that of Devon and Cornwall, i.e. post-Carboniferous. This conclusion appears to ignore a number of arguments that have been advanced in favour of an earlier age for the mineralisation of Wales and the Lake District, namely, post-Silurian. In this connexion, there is a serious contradiction in regard to the lodes of Caldbeck Fell, Lake District; on one page they are said to be later than the Wolfram veins of Carrock Fell, but on another page they are stated to be cut and displaced by those veins. We scarcely expected to see in these days the Ffestiniog beds (Cambrian) referred to in a Geological Survey memoir as Lower Silurian. Traces of this antiquated nomenclature occur also on other pages.

Department of Scientific and Industrial Research: Fuel Research Board. Technical Paper No. 14: The Enrichment of Coal Gas by the Injection of Oil into the Retorts during Carbonisation. Pp. vi + 61. (London: H.M. Stationery Office, 1925.) 1s. 9d. net.

THE volume of gas obtained from coal by carbonisation can be increased by gasifying a portion of the residual coke with the formation of water gas. The two processes can be either carried out in separate plants or combined as in the steaming of vertical retorts. Blue water gas has a low heating value which is, therefore, often increased by admixture of oil-gas as in a carburetted water-gas plant. This low calorific value of blue water gas also causes a reduction of the heating value of the mixed gas produced when "steaming" the charge in vertical retorts is practised. "Carburetting" the gas produced during this operation is a possible way of securing the gas-making advantages of "steaming" while maintaining adequate calorific value. Technical Paper 14 of the Fuel Research Board records tests made on the effect of injecting gas oil through a water-cooled tube into the charge of Glover-West Vertical Retorts while "steaming." It was found practicable to inject up to 10 gallons of oil per ton of coal carbonised, and by the combination of oil-injection with "steaming" to raise the thermal yield of gas by 14 per cent. per ton of coal. While the water cooling of the oil tube necessitated the expenditure of extra heat in the setting, in the cracking process itself this was inappreciable, and it seems possible that the water cooling can be dispensed with. The method gives promise of improving the gas-making efficiency of the continuous vertical retort and its adaptability to load-fluctuations. H. J. H.

Die Mumifizierung von Vögeln und kleinen Säugetieren ohne Abbalgen, bei Erhaltung des natürlichen Körpers. Von Ludwig Kirchroth. Pp. 74. (Klosterbeuburg bei Wien: Ludwig Kirchroth, 1923.) 2s. 6d.

THIS is the second edition of a pamphlet with a similar title published in 1906. It details the methods, worked out by the author, of preparing birds and small mammals as museum specimens, without skinning them in the manner usually adopted, and yet preserving the natural shape and form of the body. The method consists essentially in the injection of two media, one, a preserving fluid, and the other, a preparation of kaolin and fine siliceous marl, designed to prevent loss of shape due to shrinkage. The author gives full details of the instruments to be used, of the constitution of the media for injection, and of the preliminary preparations required before injection is done. Any wire supports which may be necessary for the subsequent mounting of the specimen can be inserted during the mummification process. The method is most applicable to specimens which are to be mounted for exhibition purposes. The author claims that it is easy to carry out, is cheap and speedy, and that it has stood the test of twenty years' experience. It certainly seems worthy of a trial and deserves to be more widely known. With this object in view, the author promises an English translation, at a cost of fifteen shillings, which may be obtained from him. Museum curators and taxidermists will find this pamphlet of great interest, and will be well advised to give the method a thorough and exhaustive test.

Pitman's Electrical Educator. Edited by Dr. J. A. Fleming. (Complete in 30 fortnightly Parts.) Part 1. Pp. 56. (London: Sir Isaac Pitman and Sons, Ltd., 1925.) 1s. 3d. net each part.

THE Preacher said that of writing books there is no end, and that much study is a weariness to the flesh. Judging by the contents of the first part of this popular educator, the second part of the above statement scarcely applies to this book. In the frontispiece it is stated that it is a highly valuable work for electricians, electrical engineers, contractors, apprentices and students. In addition, it is intended for those engaged on the commercial side of the electrical industry. Many eminent engineers and men of science are contributing to this volume. In the foreword, Dr. Fleming points out that electrical engineering has advanced so rapidly in recent years that it is quite impossible to deal with every part of the subject in a single volume. We are told that the student and the practical engineer desire to obtain a general acquaintance with the subject from a single book if possible, and that the articles will interest every engineer, whatever his status or knowledge. It will be seen that the programme is somewhat ambitious. We wish it success, but the first part does not enable us to judge of its practical value.

Woodcuts of British Birds. By E. Fitch Daglish. With Descriptions by the Artist. Pp. 165. (London: Ernest Benn, Ltd., 1925.) 25s. net.

MR. DAGLISH's work may be commended not only to bird-lovers but also to art-lovers. He is a master of decorative style and of his craft of wood-cutting, and

he knows his birds. Some of his portraits are triumphs—the red-backed shrike, for example, against bramble leaves; the reed bunting silhouetted upon a marvellous background of reed stems; the spotted flycatcher immobile on a laburnum perch; the long-eared owl among the most decorative of pine twigs; or the splendid blackcock busy with display. There is also the puffin and the crested grebe, the pied wagtail and the wren (the wren in a tangle of every kind of spring flower), the jay and the jackdaw—each one a penetrating portrait and at the same time a real work of art. Not all are so successful—the bullfinch looks stuffed, the dipper and the heron rather scraggy, the stonechat is enlarged too much, and is in a false pose. But the best are as good as they can be, and all are interesting. The notes on the habits and appearance of the birds are, we take it, designed to obviate the necessity of going to the library and taking down heavy histories of birds, and they are more than ample for this purpose, and pleasantly written. Would that more artists were naturalists, more naturalists artists!

Fuel Economy and Smoke Prevention. By John B. C. Kershaw. Being the third completely revised and rewritten edition of "Smoke Prevention and Fuel Economy," by W. H. Booth and J. B. C. Kershaw. Pp. xiii + 268. (London: Constable and Co., Ltd., 1925.) 16s. net.

IT is probable that the interchange of terms in the old and new editions of this work is due to the change in modern thought. Owing to the increase in the price of the raw material and the necessity for the working costs to be decreased as much as possible, it is natural that the emphasis should be placed on the fuel economy aspect of the problem rather than on the smoke abatement. The author has summarised much of the recent work on the constitution of coal, as well as some of the later work on the utilisation of low-grade fuels. The early chapters deal with the general preparation and treatment of coals, the remainder being devoted to the description and examination of the various processes for the combustion of fuels and the utilisation of waste products.

The Oxford Economic Atlas. By J. G. Bartholomew. Sixth edition, revised by John Bartholomew. Pp. xii + 64. (London: Oxford University Press, 1925.) 6s. net.

THIS is the sixth edition of an atlas first published in 1910. The number of plates remains the same, namely sixty-four, but a few desirable changes have been made, and all the plates have been revised. Prof. Lyde's interesting and suggestive introduction has also been revised. There is little to criticise in this useful work; certainly the high standard of cartography should be noted. Only a few minor matters require comment. The maps of world isobars still show low pressure in high southern latitudes. In the map of ocean currents more detail might be added in Arctic regions. The Marion and Crozet Islands are French, not British possessions, and in the map of religions the Falkland Islanders need not be shown as having no religion at all. In the map of fisheries, which includes whaling, there is no record of the valuable whale fisheries in South Georgian and South Shetland waters.

Letters to the Editor.

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Investigation of the Origin of Insular Races of Land Mollusca in the Scilly Isles.

THE study of insular species of animals has for a long time been regarded as an important adjunct to evolutionary research, and the rôle of insular segregation as a factor in specific divergence has been stressed by numerous workers. It has of later years been held that one of the best ways of studying the effects of such isolation is the intensive survey of small groups of islands of tolerably recent formation, in which the divergence can be seen at its earliest stages and perhaps correlated with any incipient ecological divergence that may be manifest in the islands in question. Surveys of this kind have been made from time to time, but the result of such work seems as yet unsatisfactory for several reasons (*e.g.* insufficiency of material, lack of information as to the forms found on the adjacent mainland, and deficiency in ecological data). As a consequence an attempt has been set on foot in the present year to tackle the problem afresh, more particularly by means of intensive collecting and ecological study and in particular by detailed comparison of insular and mainland forms obtained from similar habitats. It is not claimed that more positive results will be obtained at once by these means than by the distinguished researches of previous workers; but it is hoped that a better approach to the problem may be provided. Thanks to financial assistance from the Government Grant Committee of the Royal Society and the Godman Exploration Fund of the Natural History Museum, a short reconnaissance was made last July in the Scilly Islands and west Cornwall for the purpose of studying the land mollusca of these areas.

It is needless to say that the choice of islands suited for such a study was not easy. The Clare Island Survey and other data showed that, so far as the land mollusca are concerned, no differentiation occurs in the British Isles in islands situated only a few miles from the mainland. The scantiness of molluscan groups, otherwise suitable for such a study, in certain areas (acid rocks, pine and heather formations) had also to be considered, while questions of access and transport were also of weight. Certain of the Hebridean islands were considered suitable, but the paucity of information as to the mainland fauna of the west of Scotland induced those responsible for the survey to prefer the Scilly Isles. So far as is known at present, there are no species of British mollusca restricted to any outlying islands. A survey of this nature had, therefore, to concentrate on the search for any varietal or racial differences which might be found between the insular and mainland forms. To that end a very exhaustive knowledge of the variability of the adjacent mainland forms from which the insular types may be derived or to which they may be most closely related, was indispensable. Indeed, the significance of a varietal form which might occur, *e.g.* on Scilly, could only be assessed on the basis of a fairly exhaustive knowledge of the total variability of the relevant species in the west of England. For it is quite possible that a varietal form found on Scilly might be absent from west Cornwall, yet occur in east Cornwall or Devon. The necessity for a fairly exact knowledge of the related mainland

fauna was a strong reason for choosing the Scilly Isles in preference to the Hebrides, as the mollusca of the west of England are far better known than those of the west of Scotland.

The Scillies are a group of some 140 rocks and islands situated about 30 miles from Land's End, being divided from the mainland by a channel about 40 fathoms in depth. They resemble the extremity of the adjacent Cornish mainland in being composed of a mass of granite with a certain amount of drift and recent deposits. The general physical conditions are largely the same in the two areas except that there is a heavier rainfall in west Cornwall, rather less sunshine, and a slightly lower temperature.

The work of this year's survey was confined to collection and observation on St. Mary (Scilly) and in the area west of a line drawn from Hayle on the north coast of Cornwall to Marazion on the south coast. It was thought that in the time available a better general indication of the amount of divergence would be obtained from this comparison than from a survey of a number of the Scilly Isles themselves.

A doubt was originally entertained that, owing to the horticultural business carried on in Scilly, there might not be a danger of contamination of the fauna of the latter through imported bulbs, etc. Further examination of this possibility showed, however, that it was not a factor to be considered seriously.

St. Mary may be regarded as ecologically similar to the Cornish area except in the following features: (a) It has a maximum height of only 160 feet as compared with the maximum of more than 800 feet found near St. Ives. (b) The atmosphere is probably damper at certain periods owing to the presence of sea-fogs. (c) There is no metamorphosed slate and greenstone, as is found round the granite nucleus of the Land's End mass. We have therefore for comparison an insular and a mainland area extremely similar in ecological conditions but differing in certain details. It is in conditions such as these that we would expect to find, if the conventional view as to the origin of insular forms is correct, the beginning of racial divergence.

It is undesirable to discuss at the present moment the evidence for the date at which the Scilly Isles were separated from the mainland, though this is obviously an important question.

The Conchological Society in its list (1921) of British land and freshwater Mollusca attributed some 25 species to the Scillies out of a total of 163, while west and east Cornwall are recorded as each having 74. This year's survey has enlarged the Scilly fauna by about ten more records. So far as we know at present, this group of islands seems to contain a rather impoverished sample of the mainland fauna.

The results of this survey are as yet uncertain, and some time must elapse before an opinion can be formed on the amount (if any) of divergence between the Cornish and Scilly land molluscs. It is likely that, after a preliminary survey of the material obtained, further collections of critical forms may have to be made. At present, however, it may be said that there seems at first sight to be very little difference between the two series. In one case which has been worked out in some detail—that of *Cochlicella barbara*—exactly the same varietal forms occur on St. Mary and in the Land's End area, and in the same numerical frequency. Actually there is more difference between colonies of *C. barbara* from Somerset and Marazion than between those of Marazion and St. Mary. It may be pointed out, however, that in the question of the origin of local or insular races negative evidence is just as important as proof of positive divergence; inasmuch as it enables us to form an idea as to the local rate of evolution.

iron is made 48 in. in length, 9 in. in depth, and 12 in. broad. It is divided by partitions 6 in. apart into 8 compartments. To the first is soldered near the top two brass tubes, one connected with the tap, the other with sink to act as an overflow. All the compartments are filled with water to the same level. The box is placed on iron legs and the water in the compartment farthest from the overflow is kept boiling with a bunsen flame. To prevent the water boiling away, U-tubes are inverted over each partition so that each siphons from its neighbour. In the compartment at one extreme, the temperature is kept about at room temperature by the circulation of the tap water: at the other, it remains at about 100° C. The temperatures of the intermediate compartments and the constancy obtainable when the apparatus is running may be judged from the following figures:

	Compartments.							
	1	2	3	4	5	6	7	8
Saturday, 12.50 P.M.	22.5	25	28.5	33.5	41.5	50.5	67.5	99
Monday, 9.30 A.M.	21.75	24.5	28.0	32.5	39.0	47.5	62.0	98

The only requirements are: a sheet of galvanised iron (or copper), solder, two short pieces of metal tubing, and a bunsen. The entire cost of the apparatus is well within ten shillings. By boring holes in strips of metal or wood to place across the compartments, each of the latter may be made to hold thirty or even more test-tubes. If compressed air is laid on, the water in each compartment may be kept in motion by bubbling a jet of air through it.

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The Cause of Surface Tension.

THE reply by Mr. N. K. Adam, in NATURE of September 26, p. 464, to my note on the cause of surface tension, contains a very great deal with which I heartily agree. His method of calculating the shape and size of the drop from the surface energy is, of course, perfectly valid; as so often happens in mechanics, there are different ways of resolving the forces, each way bringing out features that the other ways do not. I can even agree with him that thinking in terms of the tension has not been found to be a good "means of gaining insight into the molecular structure of surfaces," and should not urge the actual use of this conception upon any one who prefers not to use it. Where I cannot quite follow him is in concluding that, because the tension has proved to be conceptual dynamite in practice, therefore the tension itself has no physical existence.

Perhaps a few words of further explanation might be added to my discussion of the statics of the drop. Just because the motion of the particles is so rapid, one can reason in terms of averages and proceed as in the kinetic theory of gases. Downward momentum is carried into the drop by molecules diffusing into it across the plane *P* which forms its upper boundary, and upward momentum is carried out by those that leave; the algebraic result is a steady average onflow of downward momentum into the space below *P*, equivalent to a positive downward pressure often called the "kinetic" or "thermal" pressure. In addition, there are forces acting across the boundary due to repulsion and attraction between molecules. The net result over the central part of the drop is

an average flow downward of downward momentum, equivalent to a pressure which is the ordinary "hydrostatic pressure"; its direction must be downward in the interior, because the reaction or converse aspect of the same process is an upward force or flow of upward momentum which supports the weight of the superincumbent water.

Of course, the identity of the molecules within the drop is continually changing, but that is immaterial for our present purpose. It is clear that downward momentum is, on the average, steadily flowing into the space below *P*, both for the reason just stated and through the action of gravity, and this momentum must obviously be escaping somewhere. The effect of cohesion has already been taken account of in arriving at the hydrostatic pressure. (Or, again, if cohesion holds the drop, then the drop is pulling downward on the water above instead of pressing upward upon it, and what in turn holds this water up?) The only possibility is that downward momentum is, on the whole, escaping upward through the surface skin; which is another way of saying that there is a genuine tension in the skin similar to that in a stretched sheet of rubber.

The very interesting question as to the structure of this surface skin is an entirely different matter. The particular line of attack to which I wished to direct attention merely reveals to us one of its activities.

E. H. KENNARD.

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The Isotopic Composition and the Atomic Weight of Chlorine in Meteorites.

HARKINS and Stone, in a letter under the above title in NATURE of September 19, state that they have found the atomic weight of meteoritic chlorine identical with that of chlorine as found on earth, within the limits of their experimental error. The question of the constancy of isotopic composition of chlorine has already proved of interest to several investigators, and one may recall the work of Curie in 1921 and of Gleditsch and others in 1922 and 1923, on the chlorine from certain ancient minerals. Their results are now confirmed by Harkins and Stone.

In the case of meteoritic chlorine, the matter is somewhat complicated by the question as to whether the rather small proportion of chlorine present is primary or secondary, that is, whether or not it is genuinely extra-terrestrial in origin. It may be recalled that the freshly cut iron surface of many chlorine-containing meteorites exhibits, in a humid atmosphere, a characteristic "sweating" that has been attributed to the presence of lawrencite or deliquescent ferrous chloride. Such meteorites rust rather rapidly, even on museum shelves. The late Prof. Mallet, a very keen observer and an analyst of a type now unfortunately very rare, became convinced, after work with meteorites of this kind, that the chlorine was secondary. He writes: "The exudation of watery drops containing metallic chlorides is observable only at points on the outside and on cut surfaces along the lines of fissures communicating with the outside."

Undeterred by knowledge of this uncertainty, in the autumn of 1921 the present writer determined the atomic weight of chlorine from the "shale balls" associated with the Canyon Diablo, Arizona, meteorite. Material for this investigation became available through the courtesy of a colleague, Mr. W. F. Magie. Sulphur was completely absent, a fact which weighs against the probability of contamination of the meteoritic matter by terrestrial

liquors. In the analytical work, silver chloride was reduced to silver in a current of hydrogen, and the atomic weight of "ordinary" chlorine compared with that from the meteorite. Had the result shown a difference in atomic weight, then one could have been confident that the chlorine was not of terrestrial origin. But the results were identical within 1 part in 2000, which was not outside the estimated experimental error. They were never published, because of the uncertainty as to the true source of this "meteoritic" chlorine.

It will be of interest to learn how Drs. Harkins and Stone have reassured themselves as to the extra-terrestrial origin of the meteoritic chlorine studied in their careful investigation.

ALAN W. C. MENZIES.

Princeton University,
October 10.

The Spectrum of Si^+ (Once Ionised Silicon).

PROF. A. FOWLER has recently shown that the spectrum of Si^+ is similar in constitution to that of Al, that is, consists of doublets having $2p_2, 2p_1$, as the highest terms. A number of lines, ascribed by Fowler to Si^+ , remain, however, well outside his scheme of classification, and some of these can be arranged in a group of quartets.

MULTIPLIET 1.

<i>j</i>	1	2	3
	(0)	(1)	
1	17154.38 .. 116.0 ..	17038.38	
	62.19	62.25	
	(2)	(0)	(1)
2	17216.57 .. 115.94 ..	17100.63 .. 199.89 ..	16900.74
		134.56	134.96
		(1)	(3)
3		17235.19 .. 199.49 ..	17035.70

Interval ratio . . . 116.00 : 199.89 = $\frac{2.9 : 5}{3 : 5}$ observed
(Landé)

62.20 : 134.76 = $\frac{2.3 : 5}{3 : 5}$ observed
(Landé)

This is a pp' -combination.

The intensity rule is only roughly obeyed.

MULTIPLIET 2.

<i>j</i>	1	2	3
	(1)	(0)	
1	18382.63 .. 116.48 ..	18266.15	
	339.49	339.11	
	(0)	(1)	(2)
2	18043.14 .. 116.10 ..	17927.04 .. 199.86 ..	17727.18

This seems to be an intercombination between doublet P and quartet p -terms. But none of the known doublet P 's has 339 as frequency difference.

The differences occurring in these multiplets occur in other pairs which have not yet been classified, e.g.

$$\begin{aligned} & (0) \quad (0) \\ & 18402.19 - 18286.73 = 115.46 \\ & (0) \quad (2) \\ & 18415.41 - 18280.08 = 135.33 \\ & (1) \quad (1) \\ & 20573.45 - 20373.87 = 199.58 \end{aligned}$$

The group having the successive differences 199 and 116 correspond to p -terms of a quartet series. Evidently a quartet series is possible for Si^+ , but it is only feebly developed under the usual methods of excitation. Without more data on the spectrum of Si^+ , it is not possible to find out more information on the point.

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A Slow Process Method of Cyanide Fumigation for the Control of White-Fly in Tomato Houses.

EXPERIMENTS have shown that it is possible to generate hydrocyanic acid gas from a mixture consisting of 3 parts by weight of powdered sodium bicarbonate and 1 part by weight of high grade sodium cyanide (98 per cent. purity) for the purpose of fumigating tomato houses in the control of white-fly (*Trialeurodes vaporariorum*, Westw.).

The mixture is scattered on the dry paths of the houses at the rate of one ounce to every 1000 cubic feet space. The results show that mortality for adult fly is as great as that obtained where the gas is generated quickly from sodium cyanide and sulphuric acid in jars, but the percentage mortality for the scale stages is slightly higher in the latter method.

Economically the slow generation obtains practically as good a control as the quick method, and has great advantages in the saving of labour, and in minimising risk of scorching to plants which are grown soft. Whereas one man is required to each house in jar cyaniding, a large block of houses can be fumigated by one man when using the mixture described. The same precautions are necessary for the plants as in the case of jar cyaniding, but there is greater safety in fumigating by the slow process on windy nights. It is not advisable, however, to fumigate during heavy rain in leaky houses.

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Retrograde Metamorphosis.

UNDER this denomination is understood the step-back from the normal state of an animal to that of a more primitive one. I was undergoing the strong sun-cure in Grado, an island in the Adriatic Sea, where the full sun shines for weeks together, with only slight interruptions, exposing to it the naked skin from morning until evening during the whole day. Belonging to the fair type, my body was only in some parts covered with spare hair. After some time perfectly new, very fine hair was formed on all parts of the body, and after the lapse of five weeks there was a remarkably thick cover of fine, very light hair even on those parts of the body where there was not a trace before, to prevent the body, which became dark red-brown, from being burnt. This observation has been made by me repeatedly for fifteen years, but it is not easy for others to repeat it.

BOHUSLAV BRAUNER.

Charles' (Bohemian) University,
Prague, October 7.

Prof. Andrew Gray.

DR. ALEXANDER RUSSELL's memoir of Prof. Andrew Gray, which appeared in NATURE of October 24, will be read with sympathetic interest by Prof. Gray's many friends. I must be one of the oldest of them surviving, for I was Gray's fellow-student in my uncle's natural philosophy class in Glasgow in the session 1874-75, in which he carried off the second prize and I the fifth. From my knowledge of him at that time and since, I am able to appreciate the accuracy of Dr. Russell's notice, with the exception of one small error of date. Prof. Gray succeeded my uncle (Lord Kelvin) on his resignation of the natural philosophy chair in 1899, not after his death in 1907.

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October 25.

The Transformations of the Plant World in Geological Time.¹

By Dr. D. H. SCOTT, F.R.S.

THE record of plant life in geological time is especially interesting from the fact that it shows a definite succession of phases of vegetation, each with a distinctive character of its own. So distinct are these successive floras that a high authority has even doubted whether the evolution of land plants was necessarily continuous. While the theory of descent remains undisputed among biologists, it has been suggested that there may have been, at certain periods, recurrent invasions of the land from the sea, thus giving the terrestrial flora a fresh start. Whatever we may think of this bold hypothesis, it at least serves to show that the diversity of the successive phases of plant life is more marked than their continuity. At present, however, we are concerned with the story, rather than the theory, of the succession of floras through the ages.

The word "transformation" is used for the change from one type of flora to the next. Four such great transformations are known.

1. From marine to land flora. The time of this profound change is unknown: it may have occurred about the Upper Silurian period, but some botanists would put it much earlier.
2. From the early land flora to the typical Palæozoic vegetation. Time, about the Middle Devonian.
3. From the Palæozoic to the Mesozoic type of flora. Time, Permian to Trias. This was the transformation which suggested to Prof. Seward his idea of discontinuity, referred to above.
4. From the typical Mesozoic to the modern type of flora. Time, Cretaceous. This transformation was the most important from our own point of view, as it ushered in the reign of the true flowering plants.

All these transformations, as we observe them, are apparent, not real; they mark the obvious changes in the flora, when the new groups became dominant. The actual origin of the new types must always have lain much further back than the date of the conspicuous transformation.

Of the hypothetical "Plankton" stage, when the ocean swarmed with unicellular creatures, as yet neither plants nor animals, we can have no geological evidence. The succeeding "Benthic" phase (to use Dr. Church's term), the age of the rooted Algæ, is well represented from the Cambrian onwards. Calcareous seaweeds naturally lend themselves best to preservation. Highly organised seaweeds, allied to our living Corallines, are present in the Cambrian. Calcareous Algæ of another class (Siphonæ) are found at least so far back as the Ordovician. The history of their evolution, all through the succession of strata, has been traced by Dr. Julius von Pia of Vienna, while the importance of calcareous seaweeds as rock-building organisms has been demonstrated by Prof. Garwood. A huge Alga (non-calcareous) known as *Nematophycus*, goes back to the Silurian. In the Lower Devonian of Canada, specimens three feet thick were described by Sir William Dawson. There is reason to believe that *Nematophycus* could live on land, but its structure is that

of a complex Alga. The Cambrian and Ordovician records are sufficient to show that in the ages previous to the first transformation (the invasion of the land) plant life in the sea had already attained a high grade of development.

THE FIRST TRANSFORMATION.—We have no satisfactory evidence of a land flora before the Upper Silurian,² and even then the records are scanty and scarcely free from doubt. *Psilophyton*, characterised by its leafless, spinous, forked stems and long, terminal spore-sacs, has been doubtfully recorded from the Wenlock beds of the Silurian, and is well known from the Lower Devonian. Among other Lower Devonian plants we have *Arthrostigma* (like a magnified *Psilophyton*), the moss-like capsule called *Sporogonites*, and naked forked stems or fronds (*Hostimella*). All are very simple, practically leafless plants, but there is little to show how the transition from marine life was effected.

Our best knowledge of the early land flora is derived from the Middle Devonian, but we must be on our guard here, for recent work in Germany has shown that vegetation was already far advanced at that period. In fact the Middle Devonian flora presents a mixture of apparently primitive forms and quite complex types of plants. Among the famous plants of Rhynie, Rhynia and Hornea are no more elaborate in external form than quite ordinary seaweeds, though fully equipped with a vascular system and stomata for life on land. Kidston and Lang's new genus, *Hicklingia*, may perhaps be somewhat nearer the Algæ than Rhynia. The more advanced *Asteroxylon*, with a leafy stem, is of the same age. Dr. Kräusel finds that, in a German species, no less than three form-genera, *Hostimella*, *Psilophyton*, and *Thursophyton*, occur as parts of the *Asteroxylon* plant. This quite agrees with the conclusions of Kidston and Lang.

Asteroxylon has some primitive features, and is, of course, to be reckoned as a member of the Early Devonian flora. It is the more remarkable, that on the same slab with *Asteroxylon* Dr. Kräusel found a specimen of *Cladoxylon*, a plant of singularly complex structure, hitherto only known from the Lower Carboniferous or possibly the highest beds of the Upper Devonian. Other highly organised plants were obtained from the Middle Devonian, and it is evident that in this formation earlier and later floras overlapped.

One of Kräusel and Weyland's Middle Devonian plants, *Aneurophyton*, resembles the contemporary American plant *Eospermatopteris*, the chief constituent of the fossil forest of Gilboa in the State of New York. Both appear to have had the stature and habit of Tree-ferns, but *Eospermatopteris* is described as bearing seeds, and is thus regarded as the earliest of the "Seed-ferns," which played so important a part in the Carboniferous flora.

In anatomical structure *Aneurophyton* recalls the famous "cone-bearing tree" of Hugh Miller, described by him some eighty years ago, from the Middle Old

¹ Substance of a lecture delivered before Section K (Botany) of the British Association at the Southampton meeting, 1925.

² I leave out of account the problematic *Archæoxylon Krasseri*, said to be a vascular plant from the pre-Cambrian of Bohemia. In spite of Dr. Kräusel's careful investigation, there is room for much scepticism as to this sensational record.

Red Sandstone of Cromarty. In this case only the wood is known, but Miller's fossil afforded the first evidence of highly organised plants in the Middle Devonian.

THE SECOND TRANSFORMATION.—It has become a little difficult to know where to place this. We have been accustomed to draw a sharp distinction between Early (Lower *plus* Middle) and Late (Upper) Devonian floras. Now we know that some very high types had appeared before the Middle Devonian period was over. The general *facies*, however, of the Upper Devonian vegetation was so distinctive that we may still regard it as marking the first appearance of a typical Palæozoic flora.

Here we meet with many plants with the habit of ferns, as, for example, the noble *Archæopteris hibernica* of Kiltorkan. Among such fern-like specimens there is little doubt that both true ferns and the so-called "Seed-ferns" were represented. Great club-mosses, comparable to those of the succeeding Carboniferous period, were already well developed. Plants with whorled leaves, of families more or less akin to the later calamites and horse-tails, were present. Stems, as highly organised anatomically as those of any modern conifer, indicate that gymnosperms were already flourishing. Leaves recalling those of the maidenhair tree may have belonged to some unknown type of seed-bearing plant.

Then we come, without any marked break, to the rich vegetation of Carboniferous times. The Lower Carboniferous shows the Palæozoic flora in its purest form. Seed-ferns were abundant and varied. Higher gymnosperms were finely represented by the great *Pitys* trees with leaves something like stout pine-needles. True ferns, usually of types strange to us, were common everywhere. Club-mosses attained a gigantic stature, and some of them had developed a kind of seed, an organ not known in this group after Carboniferous times. The calamite trees appeared, and in a distantly related family the cone of *Cheirostrobis* was the most elaborate cryptogamic fructification known, either fossil or recent.

The still richer Upper Carboniferous vegetation is so well known as to need little description. New groups, both of true ferns and of the seed-ferns, appeared. The investigation of the vast Chinese flora of the period by Dr. Halle is now yielding fresh examples of the latter class.

The *Pitys* trees were replaced by the well-known Cordaitan family, of lofty stature, with long leaves like a dragon-tree, and little catkins, complex in structure. The club-mosses, calamites, and sphenophylls (a group remotely allied to the horse-tail stock) reached their zenith.

All this rich and varied flora lasted on with little change into the Permian period and then came to an end. This, at least, was the case with the northern flora. Towards the close of the Palæozoic age, botanical districts became differentiated; the vegetation of India and the southern hemisphere was then different from that which prevailed in the north. The southern type (which made some local incursions into more northern areas) is known as the Glossopteris flora, from its most characteristic genus. Glossopteris and Gangamopteris, plants with simple, fern-like fronds, were probably seed-ferns. The gigantic club-mosses were

absent from the southern flora and the calamites were of different kinds. The general *facies* of the vegetation was distinct from that of the north. The age of the Glossopteris flora is now determined as Permo-Carboniferous, but some of the genera still survived in early Mesozoic times. Hence the transition appears to have been less abrupt in the south than in the north.

THE THIRD TRANSFORMATION.—So far as the northern flora is concerned, the change was complete. From the Trias onwards we find no certain examples either of seed-ferns or cordaitan trees. So far as we know, the two great Palæozoic races of seed-plants had disappeared, though perhaps a few relics may have survived. The club-mosses of the Mesozoic are few and modest. The horse-tails begin to approach those of our own day; the ferns are exceedingly numerous and varied, and belong to more or less modern families, for the most part quite distinct from those of Palæozoic age.

The seed-ferns were replaced by a vast array of so-called cycads. These plants were no doubt allied to the recent family, but the great majority of the Mesozoic forms were far more highly organised in their reproductive apparatus. In like manner the cordaitans were succeeded by the conifers, of families not unlike those still living, and by the maidenhair trees, an important race in Mesozoic times. Further, the vegetation of the world again became, in a broad sense, uniform; the botanical districts of the late Palæozoic were obliterated.

Now all this was a vast change, for which we are as yet unable to account. Yet there are some indications that the transformation was initiated at an earlier period. Foliage of a quite cycadean character is known from Permian and even Carboniferous rocks, though the evidence from fructifications is doubtful. Among conifers we have *Walchia*, a well-known genus with probable Araucarian affinities, in the Upper Carboniferous and Permian. Leaves like those of the maidenhair trees also occur in Palæozoic rocks, though they are not entirely convincing by themselves. On the whole it seems fairly clear that some of the most characteristic Mesozoic groups had already begun to appear in Palæozoic times.

The desert conditions which were prevalent in the Triassic period may, as has been suggested, help to explain the rapid change in the character of the vegetation. It is also possible that the source of many of the Mesozoic races is to be sought in the Glossopteris flora of the south, where, as already mentioned, the transition seems to have been less sudden. We are not really driven to any such violent assumption as a new invasion from the sea.

THE FOURTH TRANSFORMATION.—This great change, which became manifest during the Cretaceous period (late Mesozoic), introduced the modern type of vegetation. It has been well said that "we are still living in the Cretaceous epoch." For us, the great point of interest is the sudden advent of the true flowering plants, the angiosperms.

It is evident that the transformation was already far advanced in Lower Cretaceous times, for Dr. Marie Stopes has found a number of dicotyledonous stems of that age, with a structure as varied and as complex as that of present-day trees. There is nothing primitive about these early dicotyledons.

The Lower Cretaceous flowering plants were contemporary and associated with members of the old Mesozoic flora, cycads, and so on, which were still predominant. In the Gault and Upper Cretaceous the angiosperms have gained the upper hand, and the vegetation assumes quite a modern character. Both monocotyledons and dicotyledons are present, in about the same proportions as in the living flora. Among the former, palms, reeds, and lilies, among the latter, willows, walnuts, beeches, oaks, planes, maples, bread-fruits (found in Greenland), laurels, gum trees, ebonies, and dogbanes indicate some of the families represented. In fact the evidence shows that, from about the middle of the Cretaceous epoch, flowering plants were flourishing very much as they are now, so far, at least, as families or even genera are concerned.

We still have no clue to what Darwin called the "abominable mystery" of the sudden appearance of the higher plants. We have seen that they already existed, fully developed, in Lower Cretaceous times. It is interesting to inquire whether we have any earlier records. They are very scanty. Prof. Seward has described, from the Stonesfield Slate of Middle Jurassic age, simple, ovate leaves, like those of a dicotyledon. We cannot be certain; for there are ferns such as *Drymoglossum* with fronds somewhat similar, but dicotyledonous affinities are strongly suggested.

Much more important are Mr. Hamshaw Thomas's

discoveries in the Lower Oolite of Yorkshire, a little older than the Stonesfield Slate. He has found fruits, ranged in two rows on a stalk, each fruit enclosing a number of seeds. Thus the structure was undoubtedly angiospermous in the literal sense, for the fruit was closed. Associated with these organs Mr. Thomas finds branched stamens, with four-lobed anthers like those of an angiosperm, and also compound palmate leaves. He gives good reasons for thinking that all these remains belonged together. It is evident that Mr. Thomas's fossils throw a new light on the early history of the angiosperms, though their relation to the main line of descent is still an open question.

The series of transformations we have briefly sketched is sufficiently striking. What has been called the succession of dynasties is, no doubt, the great feature in the past history of the kingdom of plants. We have, as yet, little to show by what means one dynasty succeeded another, or how the successive dominant races were related. That each new type arose much earlier than its full manifestation is obvious, and, as we have seen, there is often direct evidence of precursors in an age previous to the transformation of the flora. To unravel the course of descent in the transition, apparently so abrupt, from each flora to the next in succession, is at present a task beyond our powers; we have attempted nothing more than to state the problem.

Photochemical Problems.

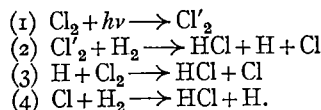
THE subject of photochemistry is one to which increasing attention is being given at the present time, as is exemplified by the large attendance and spirited controversies in the meeting, very international in character, held by the Faraday Society at Oxford on October 1 and 2. Whilst as a specialised field for the study of the action of light on chemical substances it is not without interest, in a broader sense it is the most important of all the sciences, for not only does it provide a common meeting-place for physicists, astronomers, and chemists, but, as the botanists have long observed and the medical profession is now realising, life is in great measure dependent on photochemical action.

In all photochemical reactions it is necessary to distinguish between what are termed primary and secondary processes. The first action of the light in producing chemical change is to undergo absorption by a molecule, thus converting it into an "activated" or "excited" molecule. According to the quantum theory all molecules excited or activated in this way become a distinct species characterised by a definite energy constant, which, in certain cases, is directly related to the frequency of the radiation absorbed by the relationship due to Stark and Einstein, $E = h\nu$.

It is these activated molecules which are the reacting species in photochemical processes and, according to some investigators, notably Perrin, in thermochemical change also. If all reactions were simple, it is clear that for every quantum of light absorbed one molecule should enter into chemical reaction and we should obtain a very simple relationship between the amount of chemical action obtained and the number of light quanta absorbed. Closer consideration, however, indicates that this simple law may be but rarely fulfilled,

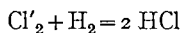
for such an excited molecule may perform one of three possible operations. It may fluoresce and thus lose its newly acquired energy by the emission of radiation. Again, it may collide with another molecule, when one of two possibilities are open to it: on collision the internal energy may be liberated in the kinetic form, resulting in what is termed a supra elastic collision, or the internal energy may be handed on to the molecule it comes in contact with, this molecule then departing as an active molecule, a process termed photosensitisation. Finally, the possibility of chemical reaction on collision is presented. It is little wonder that in many reactions the photochemical efficiency is low.

In addition to such reactions there exists an ever-increasing group in which the photochemical yield is much greater than is to be anticipated from consideration of the amount of light absorbed, or, one quantum apparently can cause several, in some cases tens of thousands of molecules to undergo reaction. Such reactions are now designated as "chain" reactions, and the various hypotheses as to their mode of action are at present a matter of heated controversy. One of the simplest explanations is that of the "atom" chain, which may be represented in operation in its simplest form by the following sequence of operations:



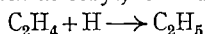
in which the primary photochemical process of activation (1) is followed by a series of steps 2, 3, 4. It is clear that 3, 4 represent two links in a chain which can only terminate when an atom is arrested in some manner.

The great ingenuity required in devising probable chain mechanism for reactions, such as the photochemical decomposition of hydrogen peroxide or the chlorination of hydrocarbons of the aromatic series, has caused many to reject this conception, originally due to Nernst, and to substitute in its place one of the following hypotheses. According to the "hot molecule" theory of Christiansen and Kramers, the products of a reaction such as



must contain not only the original energy of activation but also the energy liberated by the chemical reaction; they are thus more "active" than their neighbours. It is imagined that a "hot" molecule formed in this way may excite another reactant molecule on collision. Again, it may be imagined that this energy, instead of being contained in the products, may be liberated as radiation which is absorbed by the surrounding reactants activating them in turn; this conception has in fact been made even more concrete by the definite conception of a "quantum" chain.

More recently, due to the investigations of Frank and Cario, the scope of the methods of photosensitisation in which an excited molecule can, on collision with a reactant, hand on its energy of activation to it, thus causing subsequent chemical reaction, has been greatly extended by the employment of mercury vapour as sensitising agent. By such means the amount of energy capable of being conveyed in this manner is far greater than with the sensitising agents usually employed, such as molecules of the halogens or the dyes employed in the photographic plate. It is possible that the active nitrogen of Lord Rayleigh ($V = 9.5$ volt) may prove an even more powerful conveyer of energy than mercury atoms excited with the line $\lambda 2537$. The ready production of atomic hydrogen in this manner has opened up a path by which the properties of the organic radicals, such as ethyl, formed by the reaction



may be investigated.

Whilst these natural processes may be considered at the present time to be capable both of reasonably precise experimental investigation and their real existence capable of being demonstrated, the situation is quite otherwise in certain other phenomena, an adequate explanation for which is as yet not forthcoming.

It is found that in certain reactions hitherto considered as extremely simple in character, such as the decomposition of ozone, the photochemical efficiency may remain unchanged even for low pressures of the reactant and sensitising agent, chlorine, whilst the presence of indifferent gases exerts a marked influence on the reactant velocity. According to the experiments of Wien, the life of an excited molecule is of the order of 10^{-7} seconds and metastable forms of active molecules are as yet unknown. Whatever the active species may be in this particular reaction, it is clear that it must have a relatively long life; furthermore, it can suffer a number of collisions with indifferent gas molecules without losing its energy, this number varying with the nature of the gas. Various explanations, such as the existence of intermediate compounds, the restriction of the reaction to the walls of the vessel and replacing the concept of an excited molecule by an excited atom, have all been advanced on very slender foundation.

Finally, it would appear from consideration of the decomposition of nitrogen pentoxide at very low pressures, that the process of distribution of internal energy amongst these molecules can proceed at a rate much faster than is to be anticipated from the Maxwellian period of molecular relaxation. If, indeed, this process occurs through the agency of radiation, nitrogen pentoxide must be singularly opaque to its own self-generated radiation.

It may be anticipated that increased attention will be given to the subject of photochemistry, for it is clear that it opens a door to some of the most interesting and important fields in the region of atom dynamics, a subject on which, in the words of Goethe, we are anxious to have "more light."

ERIC K. RIDEAL.

French Contributions to Metallurgy.

THE well-known attention which has been devoted to the history of metallurgy by Sir Robert Hadfield receives an interesting supplement in a paper recently read (Oct. 5) in Paris at a congress of industrial chemistry organised by the French Society of Chemical Industry. The main theme of the address is the interrelation of British and French research in metallurgy, but the aspect, which to most readers will be found of the greatest interest, is the excellent résumé given of the debt which this subject owes to French men of science. As an example, the author pays generous tribute to the importance, in connexion with his own discovery of manganese steel, of the investigations carried out by the Terre Noire Cie. on the commercial production of ferrous alloys very high in manganese.

The paper, which is characterised by the pleasing discursiveness associated with similar lectures which Sir Robert Hadfield has already delivered on metallurgical history, contains, however, nothing more interesting than the photo-micrograph, now published

for the first time, of the structure of the iron of the famous Delhi pillar, to which the author has devoted considerable attention. To metallographers interested in the remarkable resistance of this pillar to corrosion this structure shown in Fig. 1 will be of more than passing interest. The almost complete freedom from slag throws more than a little doubt on the view that a large part in the resistance of wrought iron to corrosion, a fact still awaiting an adequate explanation, is played by inclusions of slag.

The account given of French contributions to metallurgy since the time of Réaumur (1722) is of considerable interest. In the 150 years which followed, there appeared a number of important metallurgical books in France, of which the titles of 27 are recorded. A brief account is given of the more important contributions to metallurgical knowledge during this period. Among the older names one meets those of Réaumur himself, Berthollet, Vauquelin, the discoverer of chromium, the metal which rendered the production of a rustless steel a possibility, of Berthier

and Le Play. In more recent years the tradition has been carried on by Le Châtelier, Moissan, Pourcel, Osmond, Dumas, and Guillaume, whose work on the special alloys of iron resulted in the discovery of "Invar," an iron-nickel alloy the coefficient of expansion of which at ordinary temperatures is negligible. Such a list shows how keen has been the interest taken by French scientific workers in metallurgical problems. The debt due to them is not readily appreciated, that due to Le Châtelier being even greater than Sir Robert acknowledges, since, in addition to the credit already

from so many countries to attend this Congress, I venture to point out that this very gathering itself affords an obvious testimony to the truth of the saying that "Science knows no boundaries."

We are met, here in Paris, the renowned capital of France, and, it may with truth be said, the city wherein, perhaps more than in any other throughout the whole world, science receives most help and most encouragement.

In a memoir which I communicated to the University of Oxford, towards the beginning of this year, I showed an engraving in which was represented one of the greatest scientists of medieval England, Roger Bacon, in the act of presenting a book, the record of his work, to the University of Paris, about the year 1250. During the fourteenth and fifteenth centuries Paris was, indeed, the centre of science.

The University of your city was, even then, exercising considerable influence on the universities at that time established in England. I might cite, as an example, Jean Buridan, Rector of the University of Paris, who was one of the founders of modern dynamical science. M. Picard, chief secretary of the Academy of Sciences, has already written, on this subject, a memoir most carefully and interestingly drawn up, with reference to the facts I have mentioned.

That which was true of the past centuries is still true of the present day. Paris has not lost her ancient renown in the sciences; she still preserves it, and it may very frequently be observed that the great ideas which spread through the world of science are ideas the origin of which may often be traced to distinguished Frenchmen.

I venture to believe that in uttering these sentiments I am expressing, not my own views alone, but those of my colleagues here present, and those, indeed, of the whole world. I trust that France will maintain, in the future, the position which the wisdom of her great men has won for her in the past."

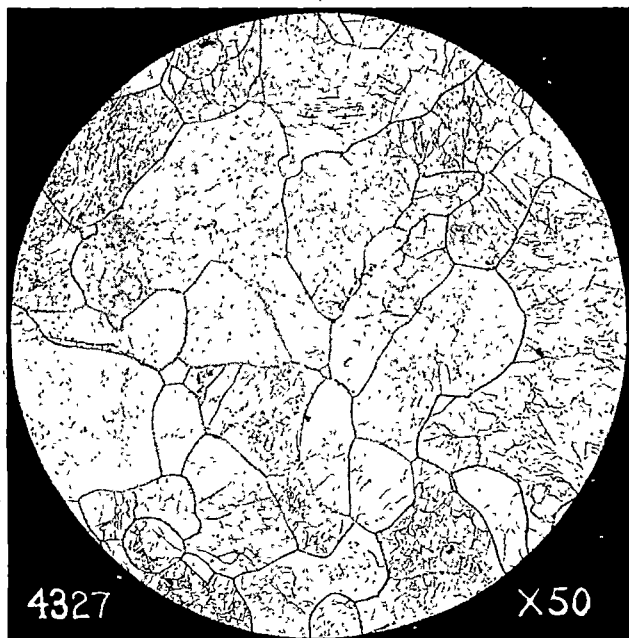


FIG. 1.—Photomicrograph of a specimen from the Delhi iron pillar

given, there must be added that due for his researches on the transformations of silica at elevated temperatures, which in no inconsiderable manner paved the way for the recent advances in our knowledge of the refractory materials in general.

Sir Robert's concluding remarks are of wide interest and may well be quoted in full:

"In offering my contribution to this distinguished gathering of prominent scientists, who have come

One cannot but be impressed throughout the address by the intimate connexion of the work of French men of science with industrial problems, a liaison which has proved of the greatest importance. A quotation by Percy, in the preface to his classical work on the "Metallurgy of Iron and Steel," from Réaumur, remains as true to-day as it was two hundred years ago: "... L'utile bien considéré a toujours de curieux, et il est rare que le curieux bien suivi ne mène pas à l'utile..." F. C. T.

The Cierva Auto-Gyro.

By Prof. L. BAIRSTOW, F.R.S.

A NEW flying machine, quite unlike the normal aeroplane and bearing a strong resemblance to a helicopter, has flown very successfully and excited general interest. It is yet too early to see the full consequences of this notable achievement, but perhaps not too soon to attempt a preliminary statement of what appears to be its general principles, in order to prevent undue expectations.

The auto-gyro has the normal parts of an aeroplane except its wings; the latter are replaced by a screw

rotating freely about an axis which is nearly vertical in flight. Except when starting, this screw or auto-gyro, is not mechanically driven, but is maintained in rapid rotation by the play of aerodynamic reactions. The forward motion of the craft is produced by the normal airscrew and engine of an Avro biplane, the body, controls, and under-carriage of which are retained, except that a very large movement is given to the elevators. Ailerons have been fitted to the craft, but are said to be unnecessary.

In flight the body of the auto-gyro appears to be supported by a flat shuttlecock, and when flying slowly its performance is astonishing. The inventor claims the possibility of flight at ten miles an hour, and exhibition flights at Farnborough in the last fortnight have shown that, when flying in a light wind, the device can hover over the ground. Furthermore, after shutting off the engine, safe descent can be accomplished at an angle of 60° to the horizontal, the craft coming to rest with a forward run of a few yards only. As at present arranged, starting from the ground is primitive; a rope is passed round projections on the auto-gyro screw and rotation up to about 60 rev. per min. produced by hauling on this rope. Taxi-ing over the ground in the normal way then brings the speed to 120-150 rev. per min., when the machine may safely leave the ground. The run is rather long.

From remarks made by the inventor, it appears that the use of the engine for starting the screw has been contemplated, so as to make it possible to rise from a confined space. The auto-gyro screw as it exists at present is unsuited for driving whilst in the air, and it is not clear that such driving would be advantageous.

From some approximate data given publicly by the inventor, it appears that the complete craft weighs about 2400 lb. and has a highest speed of flight of 68 miles per hour. The Avro biplane with the same engine weighs 1800 lb. and flies at about 90 miles per hour near the ground. So far as I know, the height to which the new machine can climb has yet to be determined.

The auto-gyro screw has four blades, the total area of which is about half that of the wings of the standard Avro aeroplane, and this makes the average loading some 30 lb. per sq. ft. as against the 6 lb. per sq. ft. of the aeroplane. In flight the device seems to be very stable and easy to control, and in this respect the invention gives a solution of one of the very difficult problems connected with the production of a successful helicopter.

The stresses due to rapid rotation are dealt with by ingenious but not novel means, and one can only marvel that in reducing the stresses the inventor has also got a stable aerodynamic system with other good qualities. The auto-gyro screw is mounted on a fixed shaft almost in the plane of symmetry of the fuselage and some 6 or 8 feet above its centre line. The four wings of the screw are hinged to a sleeve which rotates freely on ball bearings on this fixed shaft. The axes of the hinges are close to the shaft and nearly normal to it.

On the ground the weight of the blades is taken by rubber springs and guy wires, but these cease to operate in flight. The lift of the blades produces a moment tending to fold the blades upwards, and this is balanced by a moment due to centrifugal forces. By suitably curving the blades, bending stresses are almost eliminated, and as the centrifugal forces are large, a balance of moments is obtained with an upward tilt of less than 10 degrees. The same agency—centrifugal force—is left to deal with stability, gyroscopic couples, and gusts.

Due to the hinging and the varying lift on the

separate blades in the course of a revolution, a certain amount of flapping occurs. It is claimed—without great emphasis—that the flapping is beneficial to the operation of the screw, although other experiments by the inventor have shown that rotation may be maintained with a fixed screw. It is remarkable to find that forces inclined ahead of the axis of rotation exist over a wide range of speed of flight. Even when the forward speed is only 20 miles per hour, these forces urge the advancing blades to speeds upwards of 150 miles per hour at the tips. As yet there is little knowledge of the effect of forward speed on the rotational speed of the auto-gyro, possibly because the pilot has so manoeuvred his craft as to maintain a specified minimum. One of the suspicions voiced is that rotation would tend to stop at high speeds. Further, it is possible that vertical descent would be too rapid for safety; descent at an angle of 60° appears to cover most requirements when landing, and vertical descent may not be required in any case of importance.

The existence of tip speeds of 150 miles per hour readily accounts for the high average loading of the blades, since, other things being unchanged, the force per square foot of wing varies as the square of the speed. An element of wing moving at 150 miles per hour has then more than fifty times the pressure of the same wing at 20 miles per hour. There is, in fact, no need to look for new types of air flow to account for the phenomena observed. No difficulties are anticipated in analysing the performance of the auto-gyro by existing methods of calculation and knowledge of aerodynamics. From the details which this analysis will give, new developments may perhaps follow, but one general conclusion may already be drawn with some confidence. It may be expected that the auto-gyro will be a less efficient organ of transport than the aeroplane.

The arguments for such conclusion have already appeared in *NATURE* in a discussion of the possibilities of the helicopter (August 18, 1923, vol. 112, p. 229). So long as wings are used in producing lift, there will be a consequential resistance which cannot fall below a certain minimum proportion of the lift. The least amount of work expended in producing a given lift and moving a wing through a prescribed distance is then determined by conditions of airflow beyond the control of a designer. Obviously the path taken by the wings of an aeroplane between two points is the shortest possible, and the longer coiled path of the wings of a screw requires a larger expenditure of work.

This summary leads to conclusions typical of most engineering problems, no single solution containing in itself the whole of the desired qualities at their maxima. Combination of aeroplane and auto-gyro is not yet suggested, and much research lies ahead before the benefits of the new invention can be translated into terms applicable to commercial aircraft. Should uses be found for a new type of craft in which high speed and high efficiency are not essential, the new invention gives valuable help at once. No combination remotely approaching the performance of the auto-gyro at low speeds has yet appeared in the history of heavier-than-air craft.

Obituary.

PROF. H. MAXWELL-LEFROY.

IT must be with feelings of very genuine regret that entomologists, and especially those occupied with economic work, both at home and throughout the Colonies and abroad, will have learnt of the tragic death of Prof. Lefroy, which occurred on October 14, as the result of an accident. Four days previously he had been found unconscious in his laboratory at the Imperial College of Science and Technology, South Kensington, and although removed immediately to St. George's Hospital, he succumbed without having once regained consciousness. At the subsequent inquest, death was attributed to the effects of a gas with which he had been experimenting as an insecticide, whilst already suffering from toxæmia due to exposure during previous work of a similar nature extending over a period of years. The funeral took place at Kensal Green Cemetery on October 17.

Harold Maxwell-Lefroy was born in 1877 at Itchel Manor, Crondall, Hants. From Marlborough College he went up to King's College, Cambridge, graduating with first-class honours in the Natural Sciences Tripos in 1898. At Cambridge he had specialised in his old hobby, entomology, and, after a brief interlude of teaching, in 1899 was appointed entomologist to the Department of Agriculture of the West Indies. His stay at Barbadoes was not long, but it served as a very excellent introduction to the study of the entomology of the tropics, and it was no doubt largely as a result of his work there that at the end of three years he was appointed Imperial Entomologist to the Government of India. At Pusa in Bengal he found unlimited scope for the exercise of his organising abilities, and soon succeeded in placing his Department on a sound footing, and bringing it up to a level of efficiency that has been well maintained ever since. The problems which confronted him were many and varied; they seem only to have acted as an incentive to greater energy, and India owes him no small debt for the work he put in during his eight years of office there.

Chief amongst Lefroy's publications during this period were "Indian Insect Pests" (1906) and "Indian Insect Life" (1909), both of which are of standard value, whilst the latter is still the only comprehensive work on Indian insects available. Lefroy was a great believer in good illustrations, and both works are profusely illustrated. The Entomological Series of the Memoirs of the Department of Agriculture of India from the time of their commencement by him in 1906, until his retirement in 1912, likewise bear eloquent testimony to his insistence on illustration and to the range of his activities. The first memoir, on the Bombay locust, was followed by a list of the more important insects injurious to agriculture in India. This list, the first of its kind, enumerated some 150 species, the majority of which were figured, and included in the case of each a brief account of what was known of its development and bionomics, much of this information naturally being quite new. There followed a series of memoirs dealing more fully with a number of particular pests, a valuable survey of the Eri silk question, an elaborate paper on the food of birds (in collaboration with C. W. Mason), others

on biting flies, etc., the final publications dealing with insecticides, an aspect of his subject which, curiously, seemed to attract him throughout the remainder of his career more strongly than any other.

Towards the end of 1910 Lefroy returned to England and commenced work at the Imperial College of Science, where later he was appointed professor of entomology. Here he showed ability and energy as great in the creation of a school for the training of entomologists as formerly he had shown in the tackling of the economic problems of the tropics, whilst his knowledge and experience, his remarkable capacity for dealing practically with the administrative and lay aspects of insect problems, and above all his never-failing enthusiasm, personal friendliness, sympathy and generosity, have been and will remain a source of strength and inspiration to numbers of his former pupils, now widely scattered throughout the Empire.

With the outbreak of the War, as was characteristic of the man, one of his first actions was to attempt to join the colours. He was turned down. Nevertheless he succeeded in serving in various capacities quite unconnected with his scientific qualifications. As an economic entomologist he primarily devoted the greater part of his time to the house-fly problem, and also made use of his great powers as a convincing lecturer in teaching sanitary officials, doctors, and Army officers. Later he was attached, as temporary Lieutenant-Colonel, to the Mesopotamian Field Force for the specific purpose of coping with fly pests, and afterwards he was called in to deal with the wheat trouble in Australia, where he successfully applied the methods already in use in America. On his return to South Kensington he again settled down to his work of teaching, and to investigations in various directions, and was so engaged at the time of his death.

One who had the pleasure of working with him during his earliest days at South Kensington will never forget the cheerful optimism with which he undertook the most herculean labours, the extraordinary speed at which he worked, the zest with which he attacked and demolished every new obstacle, and the unexpectedness of many of his actions. The writer well remembers how, in order not to waste the day, he would start it by rising at 4 or 5 o'clock in the morning, and then cycle some twenty or thirty miles into the country to spray several acres of some friend's crops, before getting a belated but always very excellent breakfast. He was always impatient to get on. It has been said of him that much of his work was wasted; it is probably equally true to say that he himself was always the first to recognise his mistakes, as he certainly was the first to forget them in his enthusiasm for the next line of investigation. Quite unable to disguise his disgust at carping, obstructive criticism, he had little use either for ineffective discussion. To use his own words, "the training [of the economic entomologist] will have to be that of the practical field entomologist . . . and the last thing it wants to be is the academic zoological training of the average English university." It was the practical side of his work, with its innumerable opportunities for the exercise of inventive ingenuity, that always appealed to him most; the systematic

arrangement of collections, and kindred subjects, he admitted were necessities, but, as he never failed to remind his students, "systematics are no part of an economic entomologist's work, and should be left strictly to those whose concern they are."

In recent years Lefroy published little of a scientific nature, confining himself in the main to devising methods and apparatus for applying the results of his investigations, and this with no little success. Apart from this, there can be no doubt that since the War, and even during it, he rendered great service to entomology in Great Britain by his continued efforts to force the general public to a realisation of the interest and importance of the subject to which he was devoted. If in the process he employed such varied and unconventional means as newspapers and popular magazines, broadcasting, and even the cinematograph, it is none the less true that a measure of success attended his efforts which would have been absent had less spectacular methods been employed. His death at the early age of forty-eight leaves entomology the poorer by the loss of a very remarkable man.

DR. BRAYTON H. RANSOM.

DR. B. H. RANSOM, Chief of the Zoological Division of the United States Bureau of Animal Industry, died, after a brief illness, in Washington on September 17, in his forty-seventh year.

In Dr. Ransom, America has lost one of its most brilliant parasitologists. The Division of the Bureau of Animal Industry which he had administered since

1906 has played a very prominent part in the solution of many urgent problems in economic parasitology and has contributed many invaluable discoveries to science—not the least important of which was the recent introduction of carbon tetrachloride in the control and treatment of hookworm disease in man. Dr. Ransom's personal contributions to this work are so numerous that it is impossible to do more than mention a few of the more outstanding. He demonstrated the transmission of the stomach worms of horses by flies; and developed many practical control measures for stomach worms of ruminants. He did much research on the life-history of the pig ascarid and was able to devise a practical means of eradication for this important swine pest. His work on the parasites of human importance in meat products—especially in connexion with the *Trichina* worm and "Measles" of mutton and pork—was of fundamental importance. He published monographs which have even now become standard works of reference on the cestodes of North American birds, on the intestinal nematodes of ruminants, on the Heterophyid trematodes of man and other animals, and on other subjects; and many other papers of a very high scientific standard on morphology, life-history, biology and classification of the parasitic helminths have appeared from his pen.

Dr. Ransom had many friends—some of whom he had never seen—and few enemies. No man was more ready to lend a helping hand to the beginner, and many a young parasitologist owes much to his friendly assistance. In his premature death the world has lost a valuable and conscientious worker, and parasitologists a considerate and helpful friend.

Current Topics and Events.

PROF. H. A. LORENTZ took his doctor's degree at the University of Leyden on December 11, 1875. His friends wish to take the opportunity afforded by the fiftieth anniversary of that event to offer to him some token of their esteem and affection. For this purpose, a general committee including physicists from all countries, and an executive committee consisting of Prof. Kamerlingh Onnes, Prof. Zeeman and Dr. Fokker, has been formed. It is proposed to raise a fund, to be called the Lorentz Fund, to be devoted to the advancement of theoretical physics. It is intended that the fund should provide for the continuance of the lectures on problems of modern physics which Prof. Lorentz has given at the University of Leyden since his retirement from his professorship under the age limit. Other objects of the fund are to assist Prof. Lorentz's own researches, to aid the publication of treatises and scientific papers, to provide research and travelling fellowships, and generally to assist whatever may be useful for the advancement of theoretical physics. The fund will have an international character, being available for foreign physicists for work in the Netherlands and for Dutch physicists for work at centres of physical research abroad. It will be administered by the Leyden University Council. Sir J. J. Thomson, Trinity Lodge, Cambridge, will be glad to receive subscriptions for the fund.

CONSIDERABLE interest has been aroused by the discovery of part of a human cranium during excavations on the site of Lloyds' new buildings in Leadenhall Street, in the City of London. It was found by a workman at a depth of 42 ft. below the level of the street. The deposit at this point is the blue clay below the Pleistocene gravel, and it is the same stratum as that in which a skeleton of a woolly rhinoceros has been discovered. The newly discovered fragment of a human skull, which is the posterior two-thirds of the brain case, was exhibited and described at a meeting of the Zoological Society on October 20 by Prof. G. Elliot Smith and Mr. Warren Dawson, to whom it had been sent for examination. The bone is definitely mineralised, and there would appear to be no reason to doubt that it is contemporary with the stratum in which it is found, and not an intrusion of a later date. The fossilisation of the bone at the line of fracture indicates that the skull was broken in ancient times and not recently. As regards the cranial fragment itself, certain features suggest that the muscles of the neck were not of the massive character that might perhaps be expected in an early type of man, and point to the skull being that of a female, while the condition of the sutures indicates an age of about forty-five years. The endocranial cast was very much flattened and showed resemblances to the Neanderthal type. Prof. Elliot

Smith, however, is definitely of the opinion that the skull belongs, not to Neanderthal man, but to *Homo sapiens*.

AN announcement in the *Times* of October 20, that Dr. Grimme, professor of Semitic philology at the University of Munich, had discovered a record of the rescue of Moses from the Nile by "Hatshepsut, daughter of Pharaoh," has aroused considerable interest in the newspaper world. According to a despatch from the Berlin correspondent of the *Times*, the discovery was made known at a private meeting of the Society of German Citizens of the Jewish Faith; but, as a matter of fact, Dr. Grimme's suggested decipherment of the inscription in question, which was found by Sir Flinders Petrie in Sinai in 1904, was published in book form in 1923, and is reviewed by Mr. T. G. Pinches in *Ancient Egypt* for September, where there also appears an illustration of the signs which have been identified as signifying "Hatshepsut" as they appeared on the original inscription; they appear with additions made out from a photograph, and as set out by Dr. Grimme. It is, of course, uncertain that the language is Semitic, but Dr. Grimme, working on a comparison of old Phœnician and Egyptian characters, concluded that the inscription is characteristically Old Hebrew. The identification of Hatshepsut (Hyatsepsu) and Yoseph suggests that some of the characters *may* be correctly interpreted. The reviewer, while acknowledging that "there seem to be good comparisons on the Egyptian side," is of the opinion that there are grave doubts as to the justification of the comparisons on the Old Hebrew or Phœnician side.

IN *Scribner's Magazine* for October, Prof. E. James Swift discusses quackery and its psychology. His purpose is to reveal the weak spots of the human mind which make it an easy prey for the infection of humbuggery. He gives examples from ancient and present times, from various countries, of beliefs firmly held for which, however, there was no objective proof. He places the onus of self-deception on the imagination, the lure of the mysterious, and the subtle influence of obscure explanations. He compares the activities of professed conjurors and spiritists, the former consciously setting out to play on the credulity of the audience, and the others less consciously using the same devices. Every scientific observer knows the importance of the negative instance and its elusiveness unless one is prepared. When, however, we have arraigned imagination as the culprit in self-deception, we have not answered the problem of why man lends himself to deception, why a scientific training in one direction is no guarantee of accurate observation in another. Is it that the attitude of credulity is the more natural as being that of the child, which we only give up after long and laborious training, and so, the scientific attitude being late in development both in the race and in the individual, is therefore much less stable?

AN account of the twentieth Norwegian expedition to Svalbard (Spitsbergen) is contributed by Dr. Hoel to *Aftenposten* (Oslo) of September 17. The chief

object of the expedition was to complete the survey of the eastern half of the coal-field between Van Mijen Bay and Is Fjord, a somewhat difficult task owing to the thickness of the superficial deposits. In the course of mapping, a saurian skeleton about two metres long was found in Jurassic shale, west of Store Fjord, but its excavation had to be left for another year. Large portions of fossil trees of Tertiary age were found on the hills at Van Mijen Bay. On Bear Island a seam of pure galena, 30 cm. to 40 cm. thick, with other seams of mixed barytes and galena, hold out a promise of profitable working. The inner part of Is Fjord was sounded, and the chart of the waters between South Cape and Cross Bay, on a scale of 1:100,000, was completed for publication. Oceanographic observations detected a considerable increase of temperature (so much as 2° to 3° C.) at nearly all depths. The atmospheric temperature was also relatively high, and a rapid decrease of the glaciers was perceived. Dr. Hoel also remarks on the considerable diminution of the reindeer stocks, and suggests the need of preservation by law.

THE September issue of the Journal of the Franklin Institute is of exceptional interest, as it contains the report of the presentation of Franklin medals to Prof. P. Zeeman and Dr. Elihu Thomson, the former being honoured for his discoveries in magneto-optics, and the latter for his pioneer work and inventions in electricity and electrical engineering. The addresses of the recipients are printed in the same issue. Prof. Zeeman's suggestive address on "Magnetisation of Spectrum Lines: Reminiscences and Prospects" contains a reference to the very powerful magnetic fields which the research worker can now command: the strongest statical field so far obtained is 63,700 gauss (Deslandres), and the strongest field of short duration (0.01 sec.) is 500,000 gauss (Kapitzka). Dr. Elihu Thomson's constructive address reviewed the mechanical, thermal, and optical properties of fused silica, and adumbrated the use of both fused sand and fused quartz on a greatly extended scale. Large quantities of the opaque material, made from sand, will probably be used for making insulators for high-tension transmission lines, singly capable of withstanding voltages so high as 200,000. Fused silica, owing to its highly elastic nature, is well adapted for making tuning forks of standard pitch. Fused quartz is suitable for making astronomical mirrors, condensing lenses for cinematography, the temperature-compensation mechanisms of clocks and watches, standards of length, and also for optical prisms and lenses, as it is now quite easy to remove internal striæ by fusing the quartz in a good vacuum, and then subjecting it to high pressure. Fused quartz will be used in increasing quantities for the application of ultra-violet radiation in therapeutics, and possibly also in the preparation of food.

CAPT. R. B. SEYMOUR SEWELL, I.M.S., has been appointed Director of the Zoological Survey of India. Dr. Sewell was educated at Christ's College, Cambridge, and is well known for his zoological writings in connexion with Indian zoology.

THE secretary of the Moscow Society of Naturalists informs us that, on November 7, M. A. Menzbier, president and honorary member of the Society, and professor emeritus of the First Moscow University, will attain his seventieth year. As no public celebration of this anniversary is to be held, letters and congratulations should be addressed to the secretariat of the Moscow Society of Naturalists, First Moscow University, Mokhowaya, N.II.

THAT the value of the work carried out at the Imperial College of Tropical Agriculture in Trinidad is appreciated throughout the Empire is shown by the steadily increasing list of donors to the special appeal, now being conducted by the Duke of Atholl during Lord Burnham's absence abroad. Recent donations and promises include 500*l.* from Platt Bros and Co, Ltd., and 100*l.* each from the Sun Life Assurance Co. of Canada and the United Alkali Co., Ltd. Contributions may be sent to Mr. Algernon Aspinall, Secretary, 14 Trinity Square, London, E.C. 3, or to the bankers of the fund, Barclays Bank (Dominion, Colonial and Overseas), 30 Gracechurch Street, E.C.3.

THE menace of foot-and-mouth disease is again threatening Great Britain, several outbreaks having been reported in districts widely separated from one another, the origin of which is quite unknown. In consequence the Ministry of Agriculture and Fisheries has issued a circular letter directing attention to the outbreak and advising stock-owners to obtain a copy of the leaflet issued by the Ministry on the subject. This deals with the chief symptoms of the disease, and gives directions for the precautions to be taken to avoid infection and what should be done if infection is suspected. The leaflet (Form No. A 129/T.A.) may be obtained free of charge on application to the Secretary of the Ministry, Whitehall Place, S.W.

At the annual statutory meeting of the Royal Society of Edinburgh, held on Monday, October 26, the following officers were elected:—*President*: Sir Alfred Ewing; *Vice-Presidents*: Prof. J. H. Ashworth, Prof. T. H. Bearé, Dr. W. B. Blaikie, Sir Robert Blyth Greig, Prof. T. H. Bryce, and Prof. E. T. Whittaker; *General Secretary*: Prof. R. A. Sampson; *Secretaries to Ordinary Meetings*: Dr. A. Lauder, Prof. W. Wright Smith; *Treasurer*: Dr. J. Currie; *Curator of Library and Museum*: Dr. A. Crichton Mitchell.

FROM a recent number of *Sperryscope*, the organ of the Sperry Gyroscope Co., we learn that Mr. Elmer A. Sperry has just been elected a member of the National Academy of Sciences, Washington, and has also received the honorary degree of D.Sc. from the North-western University, Evanston, Ill. In being presented for the degree, Mr. Sperry was described as "An electrical engineer and a physicist who has shown remarkable skill in applying scientific methods and knowledge to the solution of practical problems; inventor of the Sperry Gyro-compass; of many valuable aeronautic instruments; of the highest power searchlight; of fire control for the United States

Navy; a pioneer electrical manufacturer in America; and a founder member of the Society of the American Institute of Electrical Engineers."

THE current session of the Royal Society of Arts will be opened on Wednesday, November 4, at 8 30 P.M., when the inaugural address will be delivered by Sir Thomas H. Holland, chairman of the council, the subject being "The Organisation of Scientific Research throughout the Empire." Other meetings before Christmas include "Colour Printing," by Mr. David Greenhill; "Recent Progress in Indian Forestry," by Prof. E. P. Stebbing, and "The Imperial College of Tropical Agriculture," by Dr. H. Martin Leake, Mr. L. S. Amery, M.P., presiding. A course of three lectures under the Cantor Trust will be delivered by Dr. R. Lessing on "Coal Ash and Clean Coal." At meetings after Christmas the following papers will be read: "Investigations in Agricultural Science at Rothamsted," by Sir John Russell; "Religions and Races in the Punjab," by Sir Michael O'Dwyer (Sir George Birdwood Memorial Lecture); "The Work of the Imperial Institute," by Sir Richard Redmayne; "Women and Children in Indian Industries," by Lady Chatterjee; "Some General Problems of Fruit Preservation," by Prof. J. McLean Thompson; "The Propagation of Electric Waves," by Mr. J. E. Taylor; "Problems in Paint and Varnish Technology," by Dr. H. Houlston Morgan; "Domestic Heating," by Dr. Mary Fishenden; "Modern Views of Vitamins," by Prof. J. C. Drummond; "Horse Traction and Motor Traction," by Mr. James Paterson; and "Indian Maps and Surveys," by Colonel W. M. Coldstream. Courses of lectures will also be delivered by Dr. G. W. C. Kaye, on "The Production and Measurement of High Vacua"; by Mr. W. F. Higgins, on "Thermometry"; and by Mr. C. R. Peers, Director of the Society of Antiquaries, on "Ornament in Britain."

IN the annual report of the Otago University Museum for 1924, Prof. Benham gives the chief place to a valuable gift of ethnographic objects by Mr. Willi Fels. This consists of three main sections. First, 200 oriental fire-arms and other weapons. Secondly, a fine series of Maori objects, including a tiki with head erect as in the Marquesan ornaments of the same name. Thirdly, material from Pacific groups other than New Zealand, among which an extensive collection of lime knives from the Massim area, which is claimed to be one of the finest in existence. These large additions accentuate the need for more exhibition space, more work-rooms, and an increased staff. Another New Zealand museum, that of Auckland, also records the acquisition of a great collection illustrating Pacific ethnology. This is the Edge-Partington collection, purchased and presented by Mrs. Selwyn Upton and Mr. W. Cecil Leys as a memorial to their father, the late Dr. T. W. Leys, long a member of the council of the Auckland Institute. The report for 1924-25 announces the commencement of the War Memorial Museum, and the hope is expressed that its opening may be made the occasion for the holding of the Pan-Pacific

Science Congress in Auckland in 1928 or 1929. The curator of this Museum is now Mr. Gilbert E. Archey, and the assistant-curator is Mr. L. T. Griffin.

WE have received a copy of Catalogue No. 13, 1925, of second-hand books offered for sale by W. H. Robinson, 4 Nelson Street, Newcastle-upon-Tyne. The list is of a miscellaneous character, but includes sections devoted to voyages and travels (including Americana), folklore and archæology, and old scientific books. The prices asked appear to be reasonable.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: An assistant pathologist at Westminster Hospital—Secretary, Westminster Hospital, S.W.1 (November 6). An assistant lecturer in the department of pharmacy of the Brighton Municipal Technical College—F. H. Toyne, 54 Old Steine, Brighton (November 7). A lecturer in agricultural chemistry at University College of Wales, Aberystwyth—Secretary (November 14). An agricultural chemist, with experience in biochemical investigation, a mycologist, an entomologist, and a botanist, principally for physiological investigations, for the Tea Research Institute about to be established in Ceylon—T. Petch, the Tea Research Institute, c/o the Ceylon Association in London, 6 Laurence

Pountney Hill, E.C.4 (November 30). An editor for a Journal of Abstracts and Reviews to be established by the British Empire Cancer Campaign—Secretary, British Empire Cancer Campaign, 19 Berkeley Street, W.1 (November 30). A junior scientific assistant in connexion with Admiralty Research—Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1. A senior water works engineer in the public works department of the Government of Nigeria—The Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/13,684). A civil engineer in the public works department of the Government of Nyasaland—The Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/14,046). A lecturer in hygiene and public health at Charing Cross Hospital Medical School—The Secretary, Chandos Street, W.C.2. A chemical engineer and an organic chemist for the Research Station, Canadian Pulp and Paper Association—The Association, 701 Drummond Building, Montreal, Canada. A clinical pathologist at the Crichton Royal Mental Hospital, Dumfries—The Physician—Superintendent. An assistant mining lecturer under the Warwickshire Education Committee—Bolton King, County Education Office, Warwick. A lecturer in physics at the Royal Technical College, Salford—Secretary for Education, Education Offices, Salford.

Our Astronomical Column.

RETURN OF FAYE'S COMET (1925 *b*).—It is welcome news that this comet, after long search, has been photographed by Dr. Baade with the 1-metre reflector at Bergedorf. It was discovered in 1843, and has been observed regularly every $7\frac{1}{2}$ years, except for the returns of 1903 and 1918. One reason for its non-detection in 1918 was the fact that Fontana's search ephemeris was based on M. Fayet's period, published in 1910, which is now known to have been two months too short. It is inadvisable to publish periods of periodic comets deduced from short arcs, as they are subject to great uncertainty.

Before the present return, Mr. Cripps computed the perturbations and published the following elements in the Journal of the British Astronomical Association, Vol. 35, No. 6.

T	1925 Aug. 6.66 U.T.
ω	$199^{\circ} 43' 15''$
Ω	$206 13 46$
i	$10 36 31$
ϕ	$34 51 29$
n	$485.42''$

It now appears that T is actually Aug. 7.56, and Mr. G. Merton gives $484.87''$ as the corrected value of n . The other elements are not much in error.

Dr. Baade's observation is as follows:

	R.A. (1925 <i>o</i>).	N. Decl.
Oct. 20 ^d 2 ^h 36 ^m 5 ^s	$8^{\text{h}} 5^{\text{m}} 18.39^{\text{s}}$	$9^{\circ} 33' 2.0''$

The magnitude of the comet was 13. A small tail was shown on the photograph.

Once the exact place was known, Dr. Stobbe re-examined earlier Bergedorf plates, and has found images of the comet on those taken on Aug. 20 and Sept. 15. These are sufficiently distinct for measurement, and will be useful for improving the elements.

It is interesting to note that five of the six periodic comets due in 1925 have now been detected. The only failure has been Schorr's comet, which was very

unfavourably placed. There are already nine recorded perihelion passages of comets in 1925, a number that has only once been exceeded; in 1898 there were ten. It was equalled in 1886 only. This shows a reawakening of interest in the search for comets, which had somewhat fallen off.

The following ephemeris of Faye's Comet for o^{h} is from the corrected elements

	R.A.	N. Decl.	$\log r$.	$\log \Delta$.
Nov. 1	$8^{\text{h}} 22^{\text{m}} 36^{\text{s}}$	$7^{\circ} 12'$	0.2620	0.1774
9.	$8 31 52$	$5 42$	0.2709	0.1659
17.	$8 39 6$	$4 16$	0.2799	0.1539
25.	$8 44 14$	$2 59$	0.2892	0.1425

THE CAPE OBSERVATORY.—The annual report of the Cape Observatory for the year 1924 deals with a very large amount of work. Investigations of special interest described in it are the parallax of Mars observed both visually and photographically at the near approach in August 1924, and the determination of the moon's semidiameter ($15' 32.70'' \pm 0.04''$) and parallax inequality from a long series of occultations going back to 1880. Both these investigations gave a value close to $8.805''$ for the solar parallax, and the Mars investigation was the means of elucidating many points about atmospheric dispersion, etc., which will be useful at the opposition of Eros in 1931. The discussion of the motion of the moon's perigee and node agreed in giving $1.294.8$ for the earth's compression.

The plates of the Cape Astrographic Catalogue are now being retaken through the glass, which will facilitate the determination of proper motions by placing them, film to film, against the earlier plates. Meridian observations of stars and heliometer observations of planets are also being carried on as usual. The working list for the former includes all stars brighter than 7.5 magnitude south of Decl. 30° south.

Research Items.

ANTIQUITIES FROM THE RUSSIAN ALTAI—Dr. Alexis Zakharow, of the Russian Historical Museum, Moscow, describes in the *Journal of the Royal Anthropological Institute*, vol. 55, pt. i., some of the antiquities from two cemeteries on the Katanda Steppe, which were discovered by W. Radloff so long ago as 1865. These antiquities, however, have never been described. The first cemetery contained 30 to 40 tombs covered with mounds of round pebbles, and a row of flat barrows, which, however, Radloff considered to be places of sacrifice. In this cemetery were found skeletons of horses with bits of iron, human remains, male and female, knives of iron, and arrowheads of iron and bone. Spearheads with tubular sockets, and fragments of a bow, were among the objects found with male burials, copper ear-rings of spiral form were with the female skeleton. In the eighth and last kurgan excavated were fragments of garments. In the second cemetery, the most interesting objects came from a large kurgan more than seven feet high and 100 feet in diameter. The skeletons of at least six horses were found in this mound. There were also a number of garments and nine figures of horses carved in wood, of which five are in full profile, two with heads turned full face, and two lying down. Figures of other animals, such as a stag, a bear, and a dragon, were also found. Small kurgans in this second cemetery produced textile material of which the decorative pattern has been reconstructed. From this it is conjectured that it is Chinese in origin and belongs to the seventh or eighth century A.D.

THE NEOLITHIC AGE IN THE NORTHERN FAYUM, EGYPT—A preliminary report by Miss Caton-Thompson on important finds made by her in the Fayum last season on behalf of the British School in Egypt appears in *Man* for October. They consisted of bone implements and pottery of Neolithic age from sites along the northern shore of the Qarun Lake. The investigations were undertaken to inquire into problems relating to the flint industry of the Fayum, and one of the results was the first discovery of pottery and bone implements to be associated with that culture. Though prehistoric sherds abound on the sites, few pots were found in sound condition. Many were practically powder only held together by salt. These had to be measured and drawn *in situ* without attempt at removal. The forms found were: globular with flattened base, globular with restricted top, rectangular dishes, cups, saucers. Some showed traces of a slip. All were badly fired. In the rectangular dish were found five lumps of hæmatite, two quartz pebbles, parts of a flint nodule, and twelve freshwater bivalve shells of *Spatha caillardi* Martens. The bone implements, which were surface finds from lacustrine clays, consisted of harpoons, with barbs of a less acute angle than the Magdalenian specimens, and bone points, bevelled and showing striations for attachment. A unique specimen has a butt end which is squared off and a grooved spiral on the stem.

UTILISATION OF PEAT—At the recent British Association meeting at Southampton, Dr. F. Mollwo Perkin gave an account of recent progress in the peat problem. The various types of peat were described, and emphasis placed on the central difficulty of reducing the water content of freshly dug peat (90 per cent. in round figures) sufficiently to permit any form of manufacture to be economically attempted. Maceration, heating and compression, electro-osmosis, chemical treatment, and combinations of several of

these have been tried, mostly without success. It is believed that a combination of maceration, heating in an autoclave followed by sudden release of pressure, and briquetting will prove a solution. The briquettes are stated to prove well suited for use in domestic heating appliances, and are of course smokeless. A plea is made for the development of such a process for utilisation of peat to produce domestic and manufacturing fuel and useful by-products.

THE PLANT AS A MEASURE OF THE HABITAT—Frederic E. Clements and Glenn W. Goldsmith publish many data in the Carnegie Institution Publication, No. 356, "The Phytometer Method in Ecology," on the growth and upon the performance of measurable functions, such as transpiration, by plants or small plant communities, which they consider form the most trustworthy index to the habitat. They consider that the increasing standardisation of such "phytometer" methods will cause them to replace the less satisfactory of the instruments designed to measure individual factors of the environment, such as the atmometer, etc. This may be so, but the individual plant is such a complex recording instrument that the interpretation of its record of the habitat, even as a guide to the behaviour of other reasonably similar plants, is often a very difficult problem, and probably it will be long before the student of plant habitat ventures to plumb the possibilities of the environment without the aid of a battery of physical instruments, each designed to record the fluctuation in one separate physical factor, as rainfall, humidity, temperature, etc.

TRANSPLANTING CROP PLANTS—In the United States, the annual value of crops which are usually transplanted amounts to nearly 200,000,000 dollars, grown on an area of 1,289,000 acres, representing 57 per cent. of the acreage and 63 per cent. of the value of all vegetables other than potatoes. This renders the work by Loomis (Mémor 87, Cornell Experiment Station) on the value or otherwise of transplanting, of great commercial value. Transplanting is becoming recognised as an economic expedient not directly promoting the development of the plant. Experiments indicated that in the early seedling stages all vegetables could be transplanted with little or no injury, but with advancing maturity the injury increased in all cases, but more in some crops than others. The roots of transplanted plants were more branched than those not moved, but the general effect of the process was to retard development, the degree of retardation depending upon the plant, its age and the conditions of transplanting; to some extent, also, the total yield was reduced. All crops seemed to be equally resistant to rapid wilting at the time of transplanting, but they varied in their ability to withstand unfavourable conditions afterwards, presumably due to differences in the rate of re-establishment of their roots. The effects of hardening off seedlings were investigated by transpiration studies before and after transplanting, which showed a more rapid recovery of the normal rate in plants previously hardened, this recovery being apparently associated with quicker root development. A clear correlation has been established between ease of transplanting and rate of new root formation, plants seriously injured by transplanting showing normal rapid top growth and slow root replacement. Root replacement seems to be the largest single factor concerned in transplanting, though the age at which suberisation of the older roots occurs may also have some bearing upon the matter in its relation to the

power of absorbing water immediately after the root tips have been broken off when the plants are disturbed.

SOUTH AFRICAN WEEDS.—One of the heritages left to South Africa by the Boer War appears to be a number of troublesome weeds, and as "Weed No. 1" in the reprints issued by the Union Dept. of Agriculture appears such an introduction, the spear thistle, *Cnicus lanceolatus*. It is curious also to read in this series of the jointed cactus, *Opuntia aurantiaca*. Introduced in the Cape Province as a garden plant in 1878 the plant is now proclaimed as a most dangerous weed, which has rendered many farms quite valueless and will cost many thousands of pounds to eradicate. Thus its habit of growing from any small fragment, which pleases its cultivator under glass in Britain, is evidently very differently regarded now in South Africa. These reprints contain excellent illustrations in colour by K. A. Lansdell, the Botanical Assistant, Division of Botany, Pretoria. Whilst South Africa thus discovers invaders to the flora flourishing far too readily, it appears to be in danger of losing many valued native plants owing to the commercial traffic in these wild flowers. The Journal of the Botanical Society of South Africa (Part 11, 1925) therefore welcomes a new ordinance passed by the Cape Provincial Council which enables the police to seize protected flowers exposed for sale and the magistrate to inflict severer penalties. At the same time the list of protected flowers has been pruned so that the law is not unnecessarily invoked, and the hope is expressed that the law will now be generally respected and its provisions enforced. Apparently the trade in protected flowers has been so profitable that fines have been comfortably paid and the law has been dead letter in practice, so that during 1924-25 the Journal estimates that the native flora disappeared from this cause more quickly than ever before.

GLACIERS OF MOUNT EVEREST.—In an article in the *Geographical Journal* for October on the rocks and glaciers of Mount Everest, Mr. N. E. Odell describes a remarkable feature of the East Rongbuk glacier which takes the form of a corridor 50 feet deep and 100 feet wide, lying longitudinally in the glacier for about three miles between the altitudes of about 18,700 and 20,000 feet. The steep sides of this trough are buttressed or pillared with fretted ice. The trough lies about 400 yards from the left side of the glacier and seems to be coincident with a medial moraine, since moraine matter was found on many parts of the floor. At the upper end of the trough, when the winter snow had gone, Mr. Odell found clear evidence of severe stress in the form of "ribbon structure" in the ice, not to be confused with the bedded structure of glacier ice due to entirely different causes. From the evidence of foliation and faulting it would appear that the trough is due to actual fusion of the ice by heat engendered in the compression, accompanied by evaporation of the fused ice. The topography of the district and the course and gradient of the glacier flows show that this explanation is feasible. Mr. Odell believes the trough to be a permanent feature of the East Rongbuk glacier. In a later part of the article evidence is given for a former great extension of the glaciers of the Mount Everest region. A geological map accompanies the article.

THE CLIMATE OF ALEXANDRIA.—A discussion on the above, compiled by Mahmoud Hamed, has been issued by the Ministry of Public Works, Egypt, as Physical Department Paper No. 19 (Government Publications Office, Cairo, price P.T. 5). Meteorological

observations were first made at Alexandria in 1869. From 1875, observations were made daily at 9 h. and 21 h., and from 1888 until 1900, observations were taken eight times daily. Afterwards, observations were under the control of the Survey Department and were made three times daily at 8 h., 14 h., and 20 h. In the spring, depressions from the Sahara sometimes pass over Alexandria and these "Khamasin" depressions usually bring hot south winds. During the summer the pressure system over Egypt remains almost undisturbed, and settled weather with cool northerly winds, and rather high humidity at Alexandria, prevails. The maximum atmospheric pressure occurs normally in January, but sometimes so early as November, or so late as February; the minimum pressure occurs in July. The coldest month is January with a mean temperature of 14° C., and the warmest is August with the mean 26°·2 C. The highest temperature ever recorded, since 1888, is 43°·7 C. on June 16, 1915, during the passage of a shallow depression over the Delta. The highest black bulb thermometer in vacuo reading at 14 h. is 64°·0 C. in May and June 1915. During the summer the sun is obscured by clouds only for about an hour and a half a day, while in the winter time it is obscured on the average for about four hours. On an average there are about five gales in the year, the majority occurring in December, January, and February. Tables and diagrams are given showing the average meteorological results. The whole work is well carried out and is of considerable interest.

PETROLEUM IN THE NETHERLANDS.—During the period 1903 to 1923 a systematic investigation into the mineral resources of the Netherlands was carried out on behalf of the Dutch Government, chiefly with the object of locating concealed coal deposits. The undertaking involved the sinking of fifty borings from 500 to 1400 metres in depth, one hundred borings varying from 25 to 200 metres, and a large number of shallow test-holes for geological examination of the superficial rocks. Operations were carried out mainly in three districts, South Limburg, North Limburg and North Brabant, and parts of East Guelderland and East Overijsel. In the last-mentioned district an interesting discovery was made of petroleum associated with Permian salt deposits overlying coal beds. A boring at Corle (1921 to 1923) had yielded gas- and oil-impregnated cores of salt, and when Government operations ceased in 1923 it was resolved to examine this well more closely for oil. Since the boring had been made primarily for salt recovery, the casing had been constantly filled with water, under high pressure, and whatever oil indications there might have been, had thus been obscured. Accordingly the water was pumped from the boring and in February 1924, and for some time afterwards, a quantity of mineral oil accumulated, of which some 250 litres were collected and submitted to laboratory testing. Dr. P. Tesch, director of the Dutch Government Geological Service, gives some account of these results in *Economic Intelligence*, published at the Hague on August 1, and states that the oil was thin, had a specific gravity of 0·84, and yielded on distillation 10 per cent. of benzine, 30 per cent. of kerosene, 55 per cent. of fuel oil, and 3 per cent. asphalt, no lubricating fractions being found. Dr. Tesch concludes that the oil originated in the Permian salt beds, and having regard to the position of the particular locality on the border zone of the Munster basin, and probably to the fact that petroleum has often been found in association with the German salt deposits, he is of the opinion that prospects are not unfavourable but, in fact, justify a continuance of exploratory operations.

These have now been taken in hand by private enterprise, but whether commercial success will ensue is a moot point.

THE THEORY OF FERROMAGNETISM.—A new theory of ferromagnetism is put forward by Mr. L. W. McKeehan in the August number of the *Physical Review*. It is assumed that magnetisation is due to intra-atomic changes, involving changes in the orientation of electronic orbits which are governed by quantum dynamics, and to inter-atomic changes (stresses and strains between the atoms). Magnetostriction, the change in dimensions which takes place in the material, originates in the changes of electronic arrangement in the atoms producing atomic magnetostriction; this sets up the inter-atomic stresses and strains. Hysteresis loss and magnetic hardness are due to the energy required to produce the local deformations which take place when successive atoms or small groups of atoms are magnetised. The very low hysteresis loss and the very high initial permeability observed in permalloy by Messrs. O. E. Buckley and L. W. McKeehan, and described by them in the same issue of the *Physical Review*, result from the fact that magnetostriction has opposite signs for the two constituents iron and nickel of this alloy, and that in small groups of atoms the atomic magnetostrictions compensate. The differences between the magnetic properties of iron, nickel, and cobalt are regarded as due to the differences between their atomic magnetostrictions. The theory gives a satisfactory explanation of the form of the B, H magnetisation curve, and is not inconsistent with the observations of Buckley and McKeehan, which show that with about 81 per cent. of nickel the magnetisation curve of permalloy is practically independent of the mechanical tension.

SOLID PHASES OF THE ALUMINIUM-ZINC SYSTEM.—The equilibrium diagram of the aluminium-zinc system has been studied by many investigators, notably Heycock and Neville, Shepherd, Rosenham and Archbutt, Hanson and Tanabe. In all these diagrams the liquidus consists of three branches, in which, in the majority of cases, the results agree with each other. The solidus and solubility lines in the solid phases show, however, a great divergence from each other. Hitherto the majority of changes in the solid phases have been investigated by the quenching method. A recent investigation by T. Ishihara, published in the 97th Report of the Research Institute for Iron, Steel, and other Metals in Japan, was undertaken in order to find a correct equilibrium of the solid phases by determining the electrical resistance and volume changes of the various phases, and also by using X-ray analysis as a supplementary aid. As a result of this work a number of alterations are suggested for the diagram. The maximum solubility of aluminium in the α constituent is found to be 0.3 per cent. at room temperatures. The author regards the β constituent as a solid solution containing an unknown concealed compound. The range of the eutectoid transformation extends from 0.3 to 65 per cent. of aluminium. The actual eutectoid composition has been found to be 21 per cent. of aluminium. The solidus of the β phase varies from 380° to 440° C., according to the concentration of aluminium. The solubility of zinc in γ varies considerably with rise of temperature. Its maximum at room temperature is 23 per cent.

THERMAL DECOMPOSITION OF OZONE.—Some experiments are described by Griffith and McKeown in the Journal of the Chemical Society of September 1925 which help to eliminate the discrepancies existing

between the results of measurements of the thermal decomposition of ozone. The decomposition is carried out with ozonised oxygen under varying pressures, alone, and in the presence of argon, nitrogen, carbon dioxide, and helium. These gases exert a positive "catalytic" effect, but oxygen acts as a negative "catalyst." The explanation of these results is based on the idea that complexes are formed and these are decomposed by collision, the complex yielding ozone in the presence of oxygen, and oxygen in the presence of the inert gases.

INFLUENCE OF ULTRA-VIOLET LIGHT ON CHEMICAL REACTIONS.—The results of experiments on the effect of ultra-violet light on dried hydrogen and oxygen have been published by H. B. Baker and M. Carlton in the Journal of the Chemical Society for September 1925. The gases, prepared from baryta solution by electrolysis, were collected over mercury in pairs of carefully cleaned quartz tubes; one dried with a plug of phosphorus pentoxide, the other left undried. The tubes were exposed to the light from the lamp after periods of two to eight, and in one case twelve weeks. In all the experiments the reaction was greater in the tubes containing the undried gases. The water formed in the earlier stages assisted the reaction if the gases were exposed to the light again before the drying agent could remove it.

AN ALTERNATIVE VIEW OF THE STRUCTURE OF PROTEIN.—Prof. Keita Shibata has a very interesting preliminary note on new views and experiments upon protein structure in the Japanese journal *Acta Phytochimica*, vol. 2, No. 2, April 1925. Whilst the twenty or so amino-acids which form on the usual view the "bausteine" of the proteins have now been known for some time, there are still singularly few observations which throw any light upon the way in which they are linked in the natural proteins, and Fischer's classic suggestion, of chains of polypeptide character, is based mainly upon the synthesis of relatively simple and diffusible polypeptides by methods which are probably inapplicable in a living system. Of recent years the long peptide chain has come under criticism again, and the suggestion of anhydrides, a type of "peptin ring," been made. Prof. Shibata has been thinking of possible analogies with the complex carbohydrates, upon the structure of which so much light has been thrown of recent years, and thus has been led to the attempt to "depolymerise" proteins by analogous methods, such as heating in anhydrous glycerine. The method has met with considerable success, many proteins passing completely into solution, and the substances thus obtained are never free amino-acids and peptides, but considerable yields of crystalline bodies are obtained, which may be recognised as anhydrides of the type of diketopiperazin derivatives. Naturally amino-acids or peptides may be attached as short side chains to these bodies; Shibata thinks that the ammonia given off during the depolymerisation arises from the free acid amide groups of those anhydrides which contain asparagin or glutamin as components. During the progress of the depolymerisation the biuret reaction is lost, and it is known that anhydrides such as asparaginimid give the violet reaction with alkali and copper salts. Furthermore, by heating anhydrides of amino-acids in glycerine in the presence of small crystals of barium hydroxide, Shibata has obtained, on subsequent precipitation with alcohol, substances which enter into colloidal solution in water, do not readily dialyse, and give many of the reactions of proteins. Further details of this important work will be awaited with interest.

The Wheatstone Memorial at Gloucester.

AS was mentioned briefly last week, p. 623, on October 19 Sir Charles Sherrington, president of the Royal Society, unveiled at Gloucester a bronze memorial tablet to Sir Charles Wheatstone, who was born at Barnwood, Gloucester, on February 6, 1802, and died in Paris, October 19, 1875. The memorial tablet is placed on the outer wall of St. Michael's Church, and on it is reproduced in low relief the portrait of Sir Charles Wheatstone, by Samuel Laurence, in the National Portrait Gallery. The lettering beneath the portrait is as follows:

SIR CHARLES WHEATSTONE
D.C.L., LL.D., F.R.S.

BORN AT THE MANOR HOUSE, BARNWOOD,
GLOUCESTER, 6 FEBRUARY, 1802.

Pioneer of the Electric Telegraph and the first, with (Sir) Wm. F. Cooke, to render it available for the public transmission of messages, 1837. Inventor of the Stereoscope, 1838. Conducted the first experiments in submarine telegraphy, 1844. Contributed to our knowledge of Acoustics and of Spectrum Analysis. Invented the Rheostat, the Polar Clock, the Automatic Transmitter and Receiver and the Rotating Mirror for determining the speed of Electricity. Applied and improved the Resistance Balance of Christie, known as the "Wheatstone Bridge." Invented the self-exciting shunt-wound Dynamo, 1867. Knighted, 1868.

DIED IN PARIS, 19 OCT., 1875.

BURIED AT KENSAL GREEN CEMETERY, LONDON.

*To commemorate his Services to Science
this Tablet is placed here on the 50th anniversary
of his death.*

Previous to the unveiling, a meeting was held in the Gloucester Guildhall, at which the Mayor (Mr. F. W. Duart-Smith) presided. At this meeting Sir Charles Sherrington, representing the Royal Society, Mr. R. A. Chattock (president of the Institution of Electrical Engineers), Col. H. G. Lyons (director of the Science Museum), Mr. F. E. Smith (president of the Physical Society), and Mr. J. C. W. Reith (British Broadcasting Co.) paid tribute to the many achievements of Wheatstone, and particularly to his genius of application; he was one of the great experimenters of last century, and his discoveries led to marked progress in many branches of physics. The early advances made in telegraphic communication were in no small measure due to him, and his discovery of the self-exciting property of the shunt-wound dynamo was of tremendous importance. Mr. William Bellows, of Gloucester, spoke of the home life of Wheatstone; he was a man of extreme modesty and failed as a lecturer: on the other hand, he possessed a personality that inspired confidence, and his genial manner to those helping in his experiments endeared him to all in his laboratory.

Sir Charles Sherrington, in the course of his address, said that as the years go by, the recollection of what Wheatstone did, not only for Great Britain but also for the whole civilised world, becomes more and more significant and an inspiration to all who contemplate it. Last century brought to light an increased knowledge of the processes of Nature and a more complete understanding of the laws which govern them, thus putting into men's hands new means of harnessing Nature's powers for the service of man and of civilisation. Amongst those to whom that advance is due was Charles Wheatstone, who will for ever be regarded as one of the most outstanding men of his time. That

was apparent and recognised during his lifetime and he received many honours, yet the far-reaching character of his achievements could not have been so evident as they are now, viewed along the perspective of the years. The flight of time has brought still further an unexampled fruition to the scientific ideas and their practical application which his genius fostered and cultivated.

If the lessening of the great spaces and distances which sunder human communities one from another on the surface of the earth, and if the enabling of them to communicate and converse as though they were near neighbours, is to help human kind and to support and advance civilisation, then the telegraph is one of the most noteworthy of human triumphs, and Charles Wheatstone was one of the benefactors of the human race.

Wheatstone always strove to enhance the practical application of science to the needs of man, but he also strove unceasingly to penetrate philosophically the secrets of Nature for the sake of truth itself. The method of electrical measurement which goes by his name is a model of elegance and accuracy. His genius had that trait of creative imagination which enabled him to foresee whither the new facts he observed might lead the spirit of man in its analysis of material Nature. Thus in an early and fundamental contribution which he made ninety years ago to what has since become a special branch of physical science, spectrum analysis, he wrote a prophetic announcement, and it is not too much to say in fulfilment of those observations that the opinion of Wheatstone stands as precursor of some of the most far-reaching investigations that we possess to-day into the physical and chemical structure of the universe.

Gifted with musical tastes, Wheatstone was in early life a maker of musical instruments. He soon contributed a number of experiments of much beauty towards the analysis of musical sounds. Akin to those may be regarded his observations on vision, his invention of the stereoscope, and his discovery that the mind can, from two flat but slightly dissimilar pictures simultaneously presented to the eyes, obtain in full perspective and with startling distinctness the third dimension of sensual space. It is interesting that to Wheatstone, the physicist, should thus be due a fundamental observation in modern psychology bearing on the synthetic powers of the mind. This formed the subject of his Bakerian lecture to the Royal Society in 1852.

Wheatstone's connexion with the Royal Society was long and intimate. He was elected when quite young, and remained a fellow of the Society until his death—a period only a few months short of forty years. He had the unusual honour of receiving two Royal medals, and twice he delivered the Bakerian lecture to the Society. Finally he received the "blue riband" of the Society, the Copley Medal, which is awarded without distinction of country for research work.

Wheatstone was indeed a man of many gifts and activities. Perhaps the time is approaching when the advance of science will depend more and more on collective investigation—when individual share towards the achievement of great results will loom less large by reason of the completer organisation of the investigations, so that the grand total will come to be attained by the participation of many investigators. But in all such achievements there will be leaders. Such was Charles Wheatstone, and such is his memory to-day. He was a leader in the making of the intellectual edifice of his time.

The University of Leeds Appeal.

THE appeal of the University of Leeds for 500,000*l.* was launched on Friday, October 23, under excellent auspices. As patron of the appeal, the Duke of York was able to announce in the Majestic Theatre, at a large and representative gathering drawn from all parts of Yorkshire, that the campaign was opened with a total sum, in hand or promised, of 157,039*l.* Considering the depressed industrial conditions at the present time, this can very reasonably be taken as an excellent beginning. The comprehensive nature of the subscription list indicates the widespread interest that has been aroused by the case put forward by the University authorities.

The rapid growth of the University since the War has produced a situation in which it is almost impossible to carry on the work efficiently unless the accommodation is extended. The present number of students is more than twice as large as before the War; the staff has been doubled; but the buildings, save for some temporary erections, remain the same. The work is handicapped by overcrowding and by the use of unsatisfactory temporary sheds and converted dwelling-houses. Departments are split up into several parts separated from one another. The proper co-ordination of the work becomes extremely difficult, if not impossible. In particular, the library, so essential to university work, is in respect of housing most defective of all. With so strong a case to put before the public, it is not surprising that widespread interest has been aroused.

Founded as the Yorkshire College of Science in 1875, and granted a Royal Charter in 1904, the University of Leeds has grown with astonishing rapidity. At the coming of age celebrations last year, delegates from all parts of the British Empire showed their appreciation of the position which it holds at present in university life. The success which has attended it during the last twenty-one years is a measure of its embarrassments at present; and it is to get rid of these embarrassments that the appeal has been put forth. It is intended to substitute for the chaotic collection of private houses and temporary hutments, which at present supplement the premises of the University, a range of buildings suitable for university work, and, at the same time, worthy of the dignity of a university.

The meeting in the Majestic Theatre was a memor-

able one. The Vice-Chancellor (Dr. J. B. Baillie), who, in the enforced absence of the Chancellor, the Duke of Devonshire, presided over the great gathering, opened with an eloquent and felicitous speech, and the high note then struck was maintained throughout. He was followed by the Duke of York, who, in the course of an inspiring appeal, said: "You, as Yorkshiremen, will do well to consider how valuable an asset to your county and your commerce, your industries, and your population, is the University of Leeds. The teaching and research work undertaken in all its forty departments contribute directly and indirectly to the services of the community."

The Speaker of the House of Commons, Mr. J. H. Whitley, M.P., in a message of encouragement and hope, incidentally referred to the fact that he was once a teacher himself, and that in his connexion with education in the West Riding he felt there was "an inexhaustible amount of both talent and character in the humbler homes of our people." The influence of impressive buildings was touched upon in characteristic fashion by the Dean of York (Dr. Foxley Norris), now Dean-elect of Westminster. While not quite convinced that the University of the North ought not to have been at York, he was sent to say that York would do its best to help the scheme for Leeds. Mr. Philip Snowden, M.P., who is a native of the West Riding, in a closely reasoned speech, said much to the point upon the functions of a university. He would like to see our universities even more democratic than they are. Without being misunderstood, he would rather see the desired half-million raised by the pound contributions of 500,000 comparatively poor people than by the large and generous gifts of a few wealthy people. He hoped that trade unions, co-operative societies, and other working-class organisations in the West Riding would take up the matter of the appeal and thus show their desire for the extension of democratic education. The Marquis of Hartington, M.P., brought a message of hope and encouragement from his father, the Chancellor of the University. A memorable meeting ended on a note of confidence and optimism, but with the words of the Vice-Chancellor in mind: the first hundred thousand ensures against failure; the last hundred thousand ensures success.

Inheritance and Insanity.

THIS year's Harveian Oration before the Royal College of Physicians of London was delivered by Sir Frederick Mott on heredity in relation to mental disease. A subject of more pressing urgency and general public interest could scarcely have been chosen. The gravest problems of individual ethics and State medicine depend entirely for their solution on the state of our knowledge concerning it; yet precise knowledge is fragmentary and may be misleading.

Sir Frederick Mott cited the inquiries of Miss Agnes Kelley a little more than ten years ago into the pedigrees of three groups of persons: adult patients in the London County asylums, high grade mental defectives, and normal children from the elementary schools of Bethnal Green, London. Insanity was very much more prevalent in the pedigrees of insane persons than in those of mental defectives, being in the proportions of 50 per cent. and 25 per cent. Conversely, mental deficiency was more apparent than insanity in the family histories of the defective children; while the charts of the normal school

showed insanity and mental deficiency only in a very small percentage of cases. Further, Sir Frederick and his co-workers collected information, extending in many instances to four and five generations, concerning 4000 individuals at one time or another in London County asylums, and came to the conclusion that there was a signal tendency to antedating in respect of dementia præcox, manic-depressive insanity and involutional melancholia: that is to say, if a parent suffered from manic-depressive insanity, or a parent or grandparent suffered from involutional melancholia or senile dementia, one or more of the descendants might suffer from dementia præcox during adolescence.

Sir Frederick, however, gave no indication of the effect on these conclusions of the present tendency to broaden the clinical conception of stereotyped, adolescent, dementia præcox which fits so neatly into board of control schedules and asylum administration. A parallel criticism occurs in consideration of his views on the genetic origin of this disease set forth in considerable detail in the course of the oration. He

outlines a correspondence between the activity of the interstitial cells of Leydig in the testis and the inception of the great sexual occurrences in ontogeny, the determination of sex and the acquirement of functional activity. Yet he says that *at birth* there was "plenty of evidence of nuclear mitosis, and I came to the conclusion that numbers of the cells had attained maturity and were on the way to a regressive atrophy." At puberty the cells of Leydig reappear, after "commencing manifestations of nuclear activity and karyokinetic figures" at eleven years. What ontogenic event coincides, then, with the "maturity" of these cells at birth?

It is evident that we know far too little of the histological appearances of the endocrine glands at successive ages in the normal animal, and of their influence upon the body functions at different periods or at any period of life. But Sir Frederick Mott is to be congratulated upon a continuity of effort in the elucidation of a baffling problem. It is to be hoped that his great labours, no less than the eminence of his advocacy, will encourage a more concerted attack upon the manifold problems of mental fitness.

The French Congress of Industrial Chemistry.

THE fifth French Congress of Industrial Chemistry was opened at Paris on October 4, under the auspices of the Société de Chimie Industrielle, and was organised in conjunction with the Exposition Internationale des Arts Décoratifs at the Grand Palais and with the centenary of Chevreul's discoveries of the nature of fats and his manufacture of the stearine candle. The Congress was preceded by a series of non-technical addresses on the applications of chemistry to a number of industries, and by a reception at the Grand Palais. The formal opening of the Congress on October 5 was presided over by Monsieur de Monzie, the Minister of Public Instruction; it included an address by Sir Robert Hadfield on his own recollections of metallurgy in France. The Congress then resolved itself into sixteen sections, in each of which important papers on many branches of chemical industry were read and discussed. The official banquet was held at the Palais d'Orsay, the chair being taken by Monsieur E. Borel, Minister for the Marine, and the formal adjournment of the Congress took place on October 8 under the presidency of Monsieur C. Chaumet, Minister of Commerce. The following two days were spent in visits to works, one group of those present inspecting factories in the neighbourhood of Paris and a second travelling to Grenoble to visit the international exhibition of water-power and works in the vicinity.

The celebration of the discoveries of Chevreul on fats and oils was held at the National Museum of Natural History, in which Chevreul did his work, on Sunday, October 11. The place of honour was taken by the President of the French Republic, Monsieur Doumergue, and, after a number of short speeches, Prof. Henry E. Armstrong delivered an appreciation of the work of Chevreul and its consequences; the silver gilt medal of the Société de Chimie Industrielle was presented to Prof. Le Chatelier and to Prof. Armstrong. The proceedings terminated in a banquet at the Club, which was during the War the Cercle Interallié and is now La Bienvenue Française. The British delegates to the Congress included Prof. Armstrong, Mr. E. C. Evans, Prof. C. S. Gibson, Mr. A. J. Greenaway, Sir Robert Hadfield, Mr. E. A. Hailwood, Sir Frederick Nathan, Sir W. J. Pope, Dr. S. Miall, Mr. A. R. Smith and Mr. E. A. Umney.

One of the most striking features of this very successful Congress, in addition to the admirable manner in which it was organised and fitted in with the exhibition and the Chevreul centenary, was the fact that quite a number of Cabinet ministers took an active and even an enthusiastic part in the proceedings. Each of these gentlemen, when he spoke, showed a clear appreciation of the importance of pure science and of its applications to industry; it is an unfortunate fact that we cannot imagine a number of Cabinet ministers taking an active and appreciative part in a congress of applied chemistry in Great Britain.

W. J. P.

University and Educational Intelligence.

CAMBRIDGE.—Lists of candidates who have passed the recent First and Second Examinations for Medical and Surgical Degrees have appeared. In the First Examination lists the number of those who satisfied the examiners before matriculating—which in most cases means that they received the necessary instruction at school—is large; the percentages of non-matriculated candidates on the several pass lists being: Pt. 1 (Chemistry), 60 per cent.; Pt. 2 (Mechanics), 80 per cent.; Pt. 3 (Physics), 67 per cent.; Pt. 4 (Biology), 40 per cent. More of these candidates take the examinations in October than at any other season of the year, but the figures quoted emphasise the fact that, while most of the public schools make it their business to prepare boys for the chemistry and physics, not a few are now also able to do so in biology.

Authorisation has been granted for the following reappointments: Dr. Duckworth (reader in human anatomy); Prof. W. E. Dixon (reader in pharmacology); Mr. S. W. Cole (lecturer in medical chemistry); Dr. T. S. Hele and Dr. F. J. W. Roughton (lecturers in biochemistry); Dr. Shillington Scales (lecturer in medical radiology and electrology).

The following have been elected to fellowships at Trinity College: Prof. G. E. Moore, Mr. A. S. F. Gow, Mr. R. V. Southwell, Mr. P. W. Duff, Dr. J. A. Chadwick, Mr. H. O. Evennett, Dr. P. Kapitza.

At Corpus Christi College Mr. T. R. B. Sanders has been appointed lecturer in engineering, while Mr. C. H. E. Smyth and Mr. R. A. Butler have been elected fellows.

At Emmanuel College the following have been awarded Research Studentships: Mr. E. G. Lewis (External), Mr. G. E. Hutchinson (Honorary), and Mr. C. Rimington, whilst grants for research have been made to Mr. A. Sopwith, Mr. W. L. Cuttle, and Mr. R. A. R. Hartridge.

The following reappointments have been made: Mr. J. T. Saunders, fellow and tutor of Christ's College, to be demonstrator of animal morphology; Mr. H. H. Brindley to be demonstrator of biology to medical students.

The Lees Knowles Lectures on military science are to be given by Maj.-Gen. Sir Frederick Maurice, K.C.M.G., whose subject will be "Statesmen and Soldiers in the American Civil War."

The degree of Doctor of Science *honoris causa* is to be conferred on Sir Edgeworth David, professor of geology at the University of Sydney. There is a pleasant rumour abroad to the effect that Sir David intends to spend some weeks in Cambridge in the near future.

EDINBURGH.—The following changes in the staff have recently taken place: Prof. J. Shield Nicholson has resigned the chair of political economy, which he has held for forty-five years; Prof. Godfrey H. Thomson has taken up duty as professor of education in succession to the late Prof. A. Darroch; Mr. A. D.

Hobson has been appointed lecturer in experimental zoology, and Mr. S. W. P. Steen and Dr. A. C. Aitken lecturers in mathematics.

LEEDS.—At a meeting on October 21 the Council expressed its thanks for the contribution promised by the Worshipful Company of Clothworkers towards the further development, equipment, and maintenance of the Textile Industries and Dyeing Departments of the University. This increased financial assistance provides for a capital grant of 18,300*l.* on buildings and permanent equipment, and for an additional annual grant of 3000*l.* during the next seven years to ensure the more efficient maintenance of these Departments. The grants made for capital endowment (buildings and equipment) since the institution of the Yorkshire College of Science now amount to 98,488*l.*; the annual grants made from 1874 to the present year amount in the aggregate to 144,804*l.*

An offer by Col. Stephenson Clark, Past-Master of the Clothworkers' Company, of a fund of 1000*l.* for the establishment of a scholarship tenable in the Clothworkers' Departments, was accepted with most grateful appreciation. A fund amounting to 2079*l.* was handed over to the Council for the establishment of a scholarship to be known as the "Arthur Smithells Scholarship." The Exchequer Grant allocated to the University by the University Grants Committee has been increased by 14,000*l.* a year.

On the grounds of intellectual distinction and of long and meritorious service to the University the title of emeritus professor was conferred upon Dr. T. Wardrop Griffith, who recently retired from the chair of medicine.

APPLICATIONS are invited by Guy's Hospital Medical School for the Beane scholarship in materia medica. The scholarship, which is of the annual value of 50*l.* and tenable for three years, is open to candidates who have received part, at least, of their medical education at Guy's Hospital. The latest date for the receipt of applications, which should be sent to the Dean, is December 19.

A COURSE of four "Armourers and Brasiers' Company" lectures on "Metal Crystals," appealing to those engaged in metallurgy, engineering, and allied industries, and to students of chemistry and physics, is to be delivered at the Chelsea Polytechnic, Manresa Road, S.W.3, by Prof. H. C. H. Carpenter, on November 5, 12, 19, and 26. The lecture hour will be 8 o'clock and admission will be free without ticket.

THE new engineering laboratories of the University College of Swansea were to be opened on October 30 by Lord Eustace Percy, president of the Board of Education. The buildings provide a floor area of 16,000 sq. ft., and this development has been made possible by the generosity of local engineering firms and collieries. The nucleus of the fund of 50,000*l.*, which is the sum required for the whole building scheme, was provided by the Welsh Engineers and Founders' Association and some donations from anthracite colliery owners led by Mr. C. F. Cleaves. The value of the plant which has been presented to the Department of Engineering now amounts to 10,000*l.*, and includes an experimental boiler plant obtained by the generosity and exertions of Sir James Kemnal. With the aid of this plant and backed by the local coal and oil industries, it is intended to make combustion engineering a prominent feature in the work of the Department. Organised visits to works are contemplated, while a course in the theory of accounts and works costing is being given voluntarily by Mr. R. A. Wetherall, Borough treasurer to the Corporation of Swansea.

Early Science at Oxford.

November 2, 1683. It was ordered, that a Loadstone should be cut *secundum Axem*, and then one half of it *secundum Aequatorem*; and triall be made, whether ye parts will retain ye same poles, which ye whole had. Mr. Piggot proposed an experiment viz: that ye needle of a compass will change its place at ye approach of ye centre of gravity of a bar of Iron, drawn up perpendicularly, from ye earth, by it. He was desired to try this experiment, before ye company ye week following. Dr. Wallis was then pleased, to shew us a draught of a chimney-peice, in ye Rectory House at Helmsdon, in Northamptonshire, which has ye date of ye Lord 1133 on it, in numeral figures; from whence it seems to appear, that numeral figures were in use amongst us, about 120 years sooner, than is generally supposed.

Dr. Aldrich discoursed of ye necessity of (at least) two drums in ye ear, otherwise in probability, he said, fourths would be agreeable notes. The anatomists are desired, to make use of what opportunity they shall have, for a farther enquiry into this matter.

1686. The Society having adjourned during ye long vacation, this day met again, and design constantly to continue their meeting.

An account was received from Dr. Wallis of a child which had on each hand 6 *fingers*, and on each foot six toes.

A Specimen from Dr. Lane of a strange *earth* which has a strong scent like Oyl of Turpentine, and upon distillation yeilds a good quantity of Chymical Oyl.

November 3, 1685. A letter was read from Mr. Ash concerning a girl in Dublin, who has several horns growing out of her skin.

Dr. Garden of Aberdeen communicated more of his observations concerning weather.

November 4, 1684. Mr. Musgrave communicated an account of a large preternatural Glandulose substance growing between the pericardium and ye heart of an Ox. The weight of ye whole substance, cleared from ye little fat &c: adjoining to it, amounted to 19½ lb. As to its figure it so far resembled a heart, that it was a long time taken for nothing else; but it was something flatter than a heart is naturally, each of ye flat sides making an equilateral triangle. In ye lungs were severall Cystides containing matter more or less fluid: one very large Cystis held some ounces of a matter not unlike that of a Steatoma.

The butcher who killed this Ox, says ye lungs grew fast to ye Pleura on both sides, which he affirms not to have happened once in 40 times in ye Cattle killed by him. He says also that this Ox though not overburdened with fat, complained much in travailing, which is easy to account for, there being not room for ye heart to be distended, as it ought, in its diastole.

Then Dr. Plot shewed some Saffron, which grew in Herefordshire; its taste was tart enough, and it seemed little unlike our best saffron, wanting only its bright or yellow-red colour, and being of a much browner and darker hue, which also by some was supposed chiefly owing to its being very dry.

He shewed us likewise an *Ovum Centennium*, which was given him that week for ye supposed Cocks-egg. It was somewhat bigger than a Pigeon's egg, of a pale box-colour, but opening it we found it nothing nigh full, otherwise not differing from an ordinary egg. So that we suppos'd it might be ye first egg of some young Pullett, one of the Society affirming, that he knew, some years since, a chick, which, wanting a day, or two of three months old, began to lay, and the eggs for some weeks were scarce bigger than this.

Societies and Academies.

LONDON.

Optical Society, October 15.—C. V. Raman and Sushul Krishna Datta: On Brewster's bands. The paper considers the explanation of Brewster's bands and other allied phenomena from the viewpoint proposed by Schuster (*Phil Mag.*, Oct. 1924). When monochromatic light is reflected by or transmitted through two parallel plates in succession, a superposition of the Haidinger ring-systems due to the two plates is obtained. When non-homogeneous light is used, the Haidinger rings disappear and also the superposition pattern, except in the special case of the differential system of the first order for two plates of equal thickness. A simple geometrical explanation is thus forthcoming why Brewster's bands can be observed even in non-homogeneous light with thick plates in this case.—T. Smith: Lagrange's theorem and stationary functions. Lagrange's theorem for several variables is expressed in a concise notation and used to evaluate a function which is stationary for small changes in each of its variables.—W. G. Collins: Some new instruments for recording rapidly varying phenomena. In these instruments a fine stylus terminating in a highly polished spherical surface of small radius rests on a travelling strip of transparent celluloid. A record of the movement of the part of the instrument to which the stylus is fixed is obtained by the permanent deformation of the surface of the celluloid by the stylus. As this deformation is produced by very slight pressure and no material is removed from the celluloid, the energy required to produce the record is very small. Only a comparatively small amount of celluloid film is required, and the record is immediately available for examination by optical methods.

ROME.

Royal Academy of the Lincei: Communications received during the vacation.—U. Cisotti: Properties of functions of complex variables on any surface.—Leonida Tonelli: Convergency of Fourier's series.—Mineo Chini: Determination of the geodetics of certain surfaces.—Luigi Fantappiè: Resolution of a class of integral equations of the first species with constant limits.—Orazio Lazzarino: Conditions of existence of Volterra's reciprocity theorem.—Stefan Mazurkiewicz: Functions satisfying a generalised Lipschitz condition.—Alfredo Sabbatini: Integral quadratic equations with variable limits.—E. Fermi and F. Rasetti: Effect of an alternating magnetic field on the polarisation of resonance light.—Felice Garelli: Contribution to the cryoscopy of solutions of gases in various solvents.—Antonio Pieroni: Certain derivatives of pyridine.—Luigi Rolla and Giorgio Piccardi: Chemical statics of electronic phenomena. The qualitative and quantitative application to ionisation phenomena of the law of mass action and of laws derived therefrom is demonstrated, and a method is developed for the calculation of the potential of ionisation.—Maria De-Angelis: New observations on dachauardite. The results of crystallographic measurements of well-formed crystals are given.—C. Jucci: The third generation of crosses between silkworms of three or of four mutations. Is the "mutation number" a unitary Mendelian character?—G. Bergami: Influence of the embryonal trephones on the cicatrization of wounds.—Vincenzo Rivera: Cure of certain vegetable tumours by means of X-rays. Cultures of *Bacillus tumefaciens* on peptone-agar are not affected by exposure to X-rays, whereas the tumours produced by this organism on *Ricinus*

communis or *Pelargonium zonale* are arrested and destroyed by the rays, the plants afterwards exhibiting normal development.

Official Publications Received.

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1924-25 (Cmd. 2401) Pp. iv+155 (London: H. M. Stationery Office.) 8s. net.
The East London College (University of London) Calendar, Session 1925-1926 Pp. 180. (London: Mile End Road, E.1.)
Charles' University of Prague (Founded 1548): Faculty of Science. Prospectus for Foreign Students, Session 1925-26. Pp. 10. (Prague.)
Museum of the Brooklyn Institute of Arts and Sciences: Report upon the Condition and Progress of the Museum for the Year ending December 31, 1924. By William Henry Fox. Pp. 68+3 plates. (Brooklyn N.Y.)
Studies on the Variation, Distribution and Evolution of the Genus *Parula*: the Species of the Mariana Islands, Guam and Saipan. By Prof. Henry Edward Crampton (Publication No. 228a.) Pp. vii+116+14 plates (Washington: Carnegie Institution.) 8.75 dollars.
Interferometer Experiments in Acoustics and Gravitation. By Prof. Carl Barus. Part 8 (Publication No. 310, Part 8.) Pp. ix+105. (Washington: Carnegie Institution.)
Papers from the Department of Marine Biology of the Carnegie Institution of Washington. Vol. 23. Some Corals from American Samoa and the Fiji Islands. By Prof. J. Edward Hoffmeister. (Publication No. 248.) Pp. v+80+34 plates. (Washington: Carnegie Institution.)
Proceedings of the United States National Museum Vol. 66, Art. 17: Illustrations of Unfigured Types of Shells in the Collection of the United States National Museum. By William Healey Dall. Pp. 41+36 plates Vol. 66, Art. 23. Miocene Gastropods and Scaphopods from Trinidad, British West Indies. By Wendell O. Mansfield. Vol. 67, Art. 19. The Adaptive Modifications and the Taxonomic Value of the Tongue in Birds. By Leon L. Gardner. Pp. 40+16 plates Vol. 67, Art. 20: A Revision of the Insects of the Aphid Genus *Amphorophora*. By Preston W. Mason. Pp. 62+18 plates. (Washington: Government Printing Office.)
Ceylon Journal of Science. Section A: Botany. Annals of the Royal Botanic Gardens, Peradeniya. Edited by T. Petch. Vol. 9, Part 3, August 14th. Pp. 249-250. (Peradeniya: Director of Agriculture; London: Dulau and Co. Ltd.) 3 rupees.
Report on the Administration of the Meteorological Department of the Government of India in 1924-25, and a General Survey of Half a Century's Work since the Establishment of the Department Pp. 34. (Simla: Government of India Press.)
Journal of the Photomicrographic Society. Vol. 12, 1924. Pp. 57+4 plates. (London: 4 Fetter Lane, E.C.4.) 7s. 6d.
London School of Hygiene and Tropical Medicine. First Annual Report to the Court of Governors, 1924-25. Pp. 10. (London.)
London School of Hygiene and Tropical Medicine. Report on the Work of the Tropical Division for the Year ended July 31st, 1925. Pp. 10. (London.)
Journal de la Société des Américanistes de Paris (reconnue d'utilité publique) Nouvelle Série, tome 17. Pp. xxi+508. (Paris: 61 rue de Buffon.) 40 francs.
Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 283: Astronomic Determinations by United States Coast and Geodetic Survey and other Organizations. By Sarah Beall (Special Publication No. 110.) Pp. v+227+13 plates (Washington: Government Printing Office.) 80 cents.

Diary of Societies.

SATURDAY, OCTOBER 31.

BRITISH ASSOCIATION OF CHEMISTS (Annual General Meeting) (at Midland Hotel, Manchester), at 8.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (Annual General Meeting) (at Newcastle-upon-Tyne), at 8.—H. P. Mould: Modernisation of Old Collieries.

MONDAY, NOVEMBER 2

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Mr. Shattock: Demonstration of Specimens in the Museum of some Bone Tumours.

ROYAL INSTITUTION, at 8.—General Meeting

SOCIETY OF ENGINEERS (at Geological Society), at 8.30.—G. O. Case: The Influence of Aggregates on the Strength and Properties of Concrete.

INSTITUTE OF ELECTRICAL ENGINEERS (Western Centre) (at Bristol), at 6.—J. W. Beauchamp: Domestic Electrification (Lecture).

INSTITUTE OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at University, Liverpool), at 7.—A. E. Malpas: Chairman's Address.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—O. S. Garland: Taking Stock.

TUESDAY, NOVEMBER 3

LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (in Philosophical Hall, Leeds), at 5.—Sectional Scientific Meeting.

MINERALOGICAL SOCIETY (Anniversary Meeting) (at Geological Society), at 8.30.—G. S. Garnett: The Dissociation of Dolomite.—B. J. Tully: A New Refractometer.—G. T. Prior: (a) The Manganese Iron of Vaulbuit Farm, Frieska District, Cape Province; (b) Meteoric Stone of Witkipp, Carolina District, Transvaal.

ZOOLOGICAL SOCIETY OF LONDON, at 8.30.—Dr. H. H. Scott: Some Congenital Malformations of the Kidney in Reptiles, Birds, and Mammals.—Dr. F. P. Stowell: Physical and Chemical Conditions in the Sea Water of the Zoological Society's Aquarium—a Comparison

with the Water of the Open Sea.—A. Loveridge: A Mite Pocket in the Gecko *Gymnodactylus laudaranus* Stoliczka.—H. C. Abraham: A Marine Spider of the Family Attidae.—Major S. S. Flower: Contributions to our Knowledge of the Duration of Life in Vertebrate Animals. IV. Birds.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Sir William Henry Ellis: Address and presentation of Medals.

ROYAL AERONAUTICAL SOCIETY (jointly with the Institution of Automobile Engineers) (at Royal Society of Arts), at 7.—Wing Commr. T. R. Cave-Browne-Cave: The Evaporative Cooling of Aero Engines and Condensation of their Exhaust Gas.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—W. C. Gray and R. E. Ansell: Some Notes on the Properties of Nickel-Silver.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (in Birmingham University), at 7.15.—The Behaviour of Sulphur Dioxide in Acid Solutions.—Dr W. Wardlaw: The Oxidising and Reducing Action of Sulphur Dioxide on Solutions of Metallic Salts.—S. R. Carter: Some Physico-chemical and Electro-chemical Aspects of Sulphur Dioxide as an Oxidising Agent.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Technical College, Cardiff), at 7.30.—F. J. Dyer: Vitamins.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (Annual General Meeting) (at North British Station Hotel, Edinburgh), at 7.30.—At 8 (jointly with Society of Chemical Industry, Edinburgh and East of Scotland Section)—Dr J. P. Tocher: Inaugural Address.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Midland Hotel, Manchester), at 7.30.—A. G. Ellis: Chairman's Address.

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Dr J. A. Smythe: Methods and Uses of Metallography.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—Dr. F. W. Aston: Atoms and X-rays (Presidential Address).

WEDNESDAY, NOVEMBER 4.

INSTITUTION OF MINING ENGINEERS (Annual General Meeting) (at Institution of Mechanical Engineers), at 11 A.M.—H. B. Mitton: Sinking of a Colliery in the East Nottinghamshire Coalfield.—Prof. H. Louis: A Novel Point in Mineral Valuation.—A. E. Mavrogordato: Miners' Phthisis, Past and Present, on the Witwatersrand, and Methods of Dust Control.—Dr H. S. Hele-Shaw and T. E. Beacham: A New Form of Air-Compressor.—Dr J. S. Haldane: Thermal Efficiency and Effectiveness of Heat-Engines.

GEOLOGICAL SOCIETY OF LONDON, at 6.30.—N. E. Odell: Preliminary Notes on the Geology of the Eastern Parts of Central Spitzbergen, with special reference to the Problem of the Hecla Hook Formation.—Dr K. S. Sandford: The Geology of North-East Land (Spitzbergen).

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Major B. Binyon: Chairman's Inaugural Address.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (Newcastle-upon-Tyne), at 7.—H. E. Skinner: The Design of Cable Ships.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall, Westminster), at 7.—J. J. Lassen: The Modern Development of Combustion Recording.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section) (at University College, Nottingham), at 7.15.—S. R. Trotman, Dr E. R. Trotman, and R. W. Sutton: An Investigation of the Nature of Wool Protein.—S. R. Trotman and H. S. Bell: The Sulphur Content of Wool.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (Derby Graduates Section) (at Cavendish Café, Derby), at 7.30.—W. B. Flint: The Motor Omnibus as a Means of Transport.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—G. D. Elsdon and P. Smith: The Determination of Palm Kernel Oil and Butter in Margarine.—Dr C. Newcomb: The Determination of Alcohol and Ethyl Chloride in Chloroform.—H. Atkinson: The Volumetric Determination of Soluble Sulphates by means of Barium Chloride and Potassium Stearate.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL SOCIETY OF ARTS, at 8.30.—Sir Thomas H. Holland: The Organisation of Scientific Research throughout the Empire (Inaugural Address).

THURSDAY, NOVEMBER 5.

ROYAL SOCIETY, at 4.30.—L. Ballif, J. F. Fulton, and E. G. T. Liddell: Observations on Spinal and Decerebrate Knee-Jerks with special reference to their Inhibition by Single Break-Shocks.—K. Furusawa: (a) Muscular Exercise, Lactic Acid, and the Supply and Utilisation of Oxygen. Part XIII. The Gaseous Exchanges of Restricted Muscular Exercise in Man; (b) A Spirometer Method of studying continuously the Gaseous Metabolism of Man during and after Exercise.—D. T. Harris: The Effect of Light on the Osculation.—To be read in title only.—Prof. A. V. Hill: The Surface Tension Theory of Muscular Contraction.—J. F. Fulton and E. G. T. Liddell: Electrical Responses of Extensor Muscles during Postural (Myotatic) Contraction.—L. N. Katz: On the supposed Pluri-segmental Innervation of Muscle Fibres.—L. N. Katz and C. N. H. Long: Lactic Acid in Mammalian Cardiac Muscle. Part I. The Stimulation Maximum.—H. J. G. Hines, L. N. Katz, and C. N. H. Long: Lactic Acid in Mammalian Cardiac Muscle. Part II. The Rigor Mortis Maximum and the Normal Glycogen Content.—Phyllis Kerridge, L. N. Katz, and C. N. H. Long: Lactic Acid in Mammalian Cardiac Muscle. Part III. Changes in Hydrogen Ion Concentration.—W. E. Garner: The Mechanism of Muscular Contraction.—R. W. Riding and Prof. E. C. C. Baly: The Occurrence of Helium and Neon in Vacuum Tubes.—Prof. O. W. Richardson: Structure in the Secondary Hydrogen Spectrum. III.—Prof. T. R. Merton and J. G. Pilley: On the Excitation of the Band Spectrum of Helium.—H. Hartley and J. E. Frazer: The Conductivity of Univalent Salts in Methyl Alcohol at 25°C.—C. S. Beals: The Arc Spectrum of Palladium. Its Zeeman Effect and Spectral Type.—N. Ahmad: Further Experiments on the Absorption and Scattering of γ -Rays.—R. A. R. Tricker: A Determination of the Variation of the Mass of the Electron with

Velocity, using Homogeneous β -Rays. Preliminary Results.—E. H. Boomer: Experiments on the Chemical Activity of Helium.—R. M. Wilmotte: On the Construction of a Standard High Frequency Inductive Resistance and its Measurement by a Thermal Method.—R. B. Brode: The Absorption Coefficient for Slow Electrons in the Vapours of Mercury, Cadmium, and Zinc.—P. Kapitza and H. W. B. Skinner: The Zeeman Effect in Strong Magnetic Fields.—F. R. Weston: The Flame Spectra of Carbon Monoxide and Water Gas. Part II.—H. S. Hirst and Dr E. K. Rideal: The Thermal Decomposition of Nitrogen Pentoxide at Low Pressures.—R. W. Gurney: The Number of Particles in the Beta-Ray Spectra of Radium B and Radium C.

LINNEAN SOCIETY OF LONDON, at 5.—M. Maxwell: The Home of the Eastern Gorilla.—Miss E. Bolton: Validity of Certain Species in Neoptera Brongni.—Dr H. S. Holden and S. H. Clarke: On the Seeding Structure of *Tilia europaea* L.

ROYAL SOCIETY OF MEDICINE, at 5.—Dr P. Watson-Williams: The Toll of Chronic Nasal Focal Sepsis on Body and Mind (Semon Lecture).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr E. Bramwell: The Myopathies (Bradshaw Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.—P. Dunsheath: Dielectric Problems in High-Voltage Cables.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Sir John A. F. Aspinall: Some Railway Notes Old and New (Thomas Hawksley Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (Joint Meeting of Birmingham and Coventry Graduates) (at Broadgate Cafe, Coventry) at 7.15.

CHEMICAL SOCIETY, at 8.—O. Silberad: Further Studies on a New Chlorinating Agent Preparation of Polychlor Derivatives of Tolene.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Section).—A. B. Smith: Some Problems on the Application of Lubricating Oils to Machinery.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Section).—H. N. Gresley: The Three-Cylinder High-Pressure Locomotive.

FRIDAY, NOVEMBER 6.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (at 11 Chandos Street, W.), at 4.45.—Dr A. I. Simey: The Prophylaxis of Common Colds.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Prof. J. Proudman, J. H. Powell, and others: Tides in Narrow Seas (Chairman, Dr H. Lamb).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Exhibition of Microscopical Preparations made from Recent Cases of Intestinal Stasis.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with the Manchester Sections of the Institute of Chemistry and the Society of Dyers and Colourists, also the Manchester Literary and Philosophical Society) (at 16 St. Mary's Parsonage, Manchester), at 7.—Sir William H. Bragg: Long Chain Molecules.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—Demonstration of the Agfa Colour Plate.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. H. Simmons: Flow Meters.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Newcastle-upon-Tyne), at 7.30.—F. D. Verrill: Shipyard Pneumatic Plant and Pneumatic Riveting.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Annual Convocation.

PHILOLOGICAL SOCIETY (at University College)

SATURDAY, NOVEMBER 7.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—G. W. Young: The Yellowstone Park, U.S.A. (Lecture).

PUBLIC LECTURES.

SATURDAY, OCTOBER 31.

HORNIMAN MUSEUM (Forest Hill), at 9.30.—C. D. Forde: Stone-Age Man in Brittany.

MONDAY, NOVEMBER 2.

KING'S COLLEGE, at 5.30.—C. J. Gadd: The Science of Divination.—R. J. Bartlett: Psychology and Advertising.

TUESDAY, NOVEMBER 3.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakley: The Philosophy of Aristotle. (Succeeding Lectures on November 10, 17, 24, and December 1.)

UNIVERSITY COLLEGE, at 5.30.—P. Flemming: Bloomsbury and the Bedford Estate: a Study in Street Names.

WEDNESDAY, NOVEMBER 4.

UNIVERSITY COLLEGE, at 5.30.—Prof. W. M. Calder: The Early Christian Inscriptions of Asia Minor. (Succeeding Lectures on November 5 and 6.)

THURSDAY, NOVEMBER 5.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—W. G. Constable: English Medieval Painting.

KING'S COLLEGE, at 5.30.—Prof. Winifred Cullis: The Influence of the Home in Social Hygiene.

CHELSEA POLYTECHNIC, at 8.—Prof. H. C. H. Carpenter: Metal Crystals ("Armourers and Brasiers' Company" Lectures). (Succeeding Lectures on November 12, 19, and 26.)

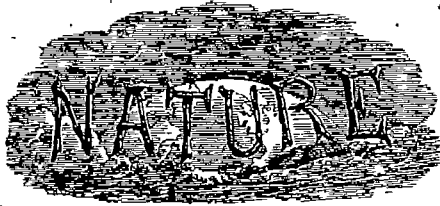
FRIDAY, NOVEMBER 6.

KING'S COLLEGE, at 5.30.—Prof. J. S. Huxley: Science and Culture.

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Contemporary English Philosophy. (Succeeding Lectures on November 13, 20, 27, December 4 and 11.)

SATURDAY, NOVEMBER 7.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. A. Smith: Aspects of Roman London. I.



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The Coal Crisis.

IT would appear as though the British public had been awakened only quite recently to the fact that the coal industry of Great Britain, upon the well-being of which the very existence of the nation depends, is in a very critical condition; needless to say, those engaged in the industry have long been well aware of it. With the general realisation of the fact by the public at large, has come a flood of suggested remedies of all kinds, most of them from people outside the industry. Thus quite recently the Sociological Society has been discussing the subject in a series of papers, but it cannot be said that anything of value has emerged from that discussion. Most sensible persons are wise enough in cases of serious illness to call in a properly trained medical practitioner, who understands the nature and causes of diseases, rather than trust to the ministrations of laymen, however intelligent or however well meaning. The sociologists have done what people in the latter category are only too apt to do; they have suggested palliatives directed to the symptoms, but not one of them has even recognised the actual cause of the disease.

Something of the same kind may be said of other suggestions that are being persistently obtruded upon the public notice, none of which is being put forward more insistently than low-temperature carbonisation. Unfortunately, in many instances the advice, so far as this process is concerned, is not wholly disinterested; the serious needs of the situation are being exploited for propaganda purposes, particularly by those who have already invested money in one or other of the low-temperature carbonisation processes. Apart, however, from this aspect of the subject, careful consideration will show that this or any other method of utilising the coal when obtained cannot possibly touch the root of the evil. If it were granted that low-temperature carbonisation could do all that its most zealous advocates claim for it—a hypothesis which is unfortunately far enough removed from actual fact—no such process could bring any real help to the coal industry.

It is claimed that by the substitution of low-temperature coke for raw coal in our domestic fireplaces our cities would be clear of smoke, and it is hinted that our domestic coal bill might even be decreased. It seems, however, to be overlooked that it is quite possible to attain these desirable objects by methods which, instead of being as doubtful as those of low-temperature carbonisation are to-day, have stood the test of generations. We have only to turn to Germany, where we can see that these excellent objects are attained by the simple system of substituting the closed stove for the open fireplace. Every one who has been on the continent knows how relatively clear the atmosphere of the large towns is, whilst statistics show that, whereas in

Great Britain we consume 15 cwt. of coal per head of population per annum for domestic purposes, the consumption in Germany is only 5 cwt.

Here, then, is a proved method for attaining what low-temperature carbonisation claims to be able to do, though it has never shown that it can do it. The only difficulty lies in persuading the Englishman to do away with his open fireplace with its no doubt wasteful but certainly cheerful flaming fire! The persistence with which we in Great Britain cling to this method of heating is usually put down to innate conservatism, but it is just possible that there may be a sounder reason. Along with the many advantages of our island home we have to take the corresponding drawback of our insular climate with its mists, grey skies and dull days, and it may quite well be that the desire for light as well as heat in our rooms may be unconsciously based upon a psychological or even upon a physiological need. Apart from this consideration, it is quite clear that the substitution of the stove for the open fireplace would have the same results here as it has in Germany, where the winter climate is more severe than it is with us.

As regards the application of low-temperature carbonisation to industrial uses, we in Great Britain could reap no benefit therefrom; even if it be assumed that by means of this process considerable economies in the utilisation of coal might be effected, this would cause injury rather than an advantage to the coal industry. It is quite impossible under modern conditions that any such improvement in the utilisation of coal can be confined to any one nation, and it is surely clear that a nation which, like our own, depends so largely upon the export of coal, can gain no advantage by any process which makes for a decreased consumption of fuel. Our main source of existence is by the export of coal directly or indirectly; not only do we sell coal abroad, but also, whenever we import Spanish iron ore and export rails, or import raw cotton and export piece goods, we are exporting coal indirectly. If we learn to manufacture these products with a smaller consumption of coal, our competitors abroad will do the same thing, and the more the consumption of coal is decreased per unit of goods produced, the smaller is the advantage which we reap from our coal supplies. It would, therefore, seem tolerably clear that, wherever the remedy for the present critical condition of the coal trade is to be found, it will not be in low-temperature carbonisation or in any similar process having for its object the more economical use of coal for industrial purposes.

Another remedy which is being urged insistently in certain quarters is the nationalisation of the coal industry. A Bill was promoted in Parliament some time ago purporting to nationalise the industry, though its real effect would have been syndicalisation rather than

nationalisation, or, in other words, the handing over of the collieries of the country to the Miners' Federation. We can only guess what the result would be from previous experiments along that line. It is now a good many years ago since the Yorkshire Miners' Federation made such an experiment by the purchase of Shirland Colliery—a colliery which had up to then been a profitable and prosperous concern. It would appear that in the first year after the purchase a small profit was made, in the next year a small loss, and in the third year a loss so considerable that the Federation was glad to dispose of its purchase at a loss.

The nationalisation of a highly speculative industry, as mining always must be, would appear to be foredoomed to failure. There are two examples of the nationalisation of coal-mining on any considerable scale; the first was in the Saar coalfield, the greater portion of which was, before the War, State-owned and State-worked by the Prussian Government, which was probably as well adapted as any Government in the world could be to obtain successful results; yet it was conclusively shown that Government-worked coal cost more to produce and yielded smaller profits than the coal produced by private enterprise in Westphalia. More recently we have the example of Soviet Russia before us, and it is possible to compare the results obtained in the Donetz Coal Basin in 1924 with those of 1913. Before the War the Russian coal-mines were self-supporting; in 1924 they received heavy subsidies from the State; in spite of this, wages were lower by 59.2 per cent. than they were in pre-War times, the output per man was 41.9 per cent. less than in pre-War times, and the total output was just under one-half of what it was in 1913. It would be difficult to show more clearly the disastrous effects of nationalisation upon the coal-mining industry.

It is frequently stated that the great development in the use of water power and of power generated from oil has seriously interfered with the demand for coal. On a subject like this it is impossible to obtain close figures, but approximate estimates would appear to show that the inroads made by these two sources of power have not as yet assumed very serious proportions. It may be roughly reckoned that the world's requirements of power are of the order of 160 million h.p. evolved continuously throughout the year; of this, according to the recent World Power Congress, the amount of the developed water power in the world supplies about 17 million h.p., whilst the power generated from oil is probably about 15 million h.p., so that these two together only produce about one-fifth of the world's power requirements, in addition to which we have the world's requirements of coal for metallurgical purposes, for which it can be replaced neither by oil nor by water power. On the other hand, it must be admitted that

the substitution of oil and water power for coal hits Great Britain particularly hard, because the former replaces the coal which we used to sell for bunkers, whilst the latter has in part replaced the coal which we used to sell to continental railways. In respect of the latter, however, we have ourselves largely to blame. The reason why some continental countries have developed hydro-electric schemes and electrified their railways is not because they hope to effect any very great savings in running costs in this way, but, as one of them put it, because they now have a source of power which will not go on strike.

It can be said with confidence that none of the remedies above mentioned, nor the many others urged upon the public mind, touch the real root of the trouble, but that everybody who has studied the economics of the coal industry would be found to be unanimous as to where the real trouble lies. The injury to our export trade due to continued threats of strikes is a subsidiary cause of our difficulties, but the main cause lies in the fact that our coal costs too much in wages; economies in other departments of the industry can no doubt be effected, but they must necessarily be insignificant compared to economies in wages, seeing that wages form something like three-fourths of the cost of producing coal. This statement does not mean that the wages per day of the coal-miner should be decreased (it may perhaps even mean exactly the opposite), but what it emphatically does mean is that there are more men engaged in the coal industry to-day than that industry is capable of supporting. This statement is particularly true of the off-hand men, the proportion of whom to hewers has increased enormously since pre-War days owing to a variety of causes, mainly perhaps to the seven hours Act.

Whilst the cause of our difficulties in the coal trade is thus tolerably well known, the means of remedying it are by no means so obvious, and it is to be sincerely hoped that the Coal Commission now sitting will find the proper remedy to apply. That there must be a remedy cannot be doubted, and that it could be produced if everybody interested were determined to find and apply it seems more than probable. The British coal industry has been through serious crises before now, and has survived them; the main difference between the present position and previous ones is that on all previous occasions everybody in the coal industry was labouring whole-heartedly towards the restoration of the industry, whereas to-day there is a party within the industry the main object of which appears to be to achieve its destruction. It is this tendency above all others which the Coal Commission will have to find means to combat, if it is to save the coal industry, and with it the nation, from ultimate ruin.

HENRY LOUIS

· Mostly Animal Genetics.

- (1) *Genetics in Plant and Animal Improvement*. By Donald Forsha Jongs. (Wiley Agricultural Series.) Pp. viii+568. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 20s. net.
- (2) *Animal Breeding*. By Prof. Laurence M. Winters. (Wiley Agricultural Series.) Pp. x+309. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 13s. 6d. net.
- (3) *Animal Genetics: an Introduction to the Science of Animal Breeding*. By Dr. F. A. E. Crew. (Biological Monographs and Manuals.) Pp. xx+420. (Edinburgh and London: Oliver and Boyd, 1925.) 15s. net.
- (4) *Experiments in Genetics*. By Dr. Charles Chamberlain Hurst. Pp. xxiv+578. (Cambridge: At the University Press, 1925.) 50s. net.

SINCE the rediscovery of Mendel's now famous paper led to the creation of a science of genetics, there has been a steady flow of treatises dealing with this branch of biology, and it is not without interest to mark how the motives that have prompted the study of this science have been reflected in the stream of books that treat of it. The man of science, as was natural, was first in the field, partly in his delight over the workings of a beautiful new tool for the shaping of thought, partly because he was spurred on by the self-imposed duty of co-ordinating the new knowledge, and of suggesting the most promising lines of further advance. It is to impulses of this sort that we owe the existence of such books as those earlier ones of Bateson and of Baur, and the more recent ones of Morgan and his colleagues, fresh with the joy of discovery and recking little of possible applications. Then, as genetics makes good and is pushed into the academic curriculum, comes the demand for the student's text-book, less critical and more dogmatic, generally written by one of greater experience in teaching than in research. Later, as the significance of the science dawns upon the practical breeder and his immediate advisers, comes the output of books in which the dominant motive is the application of genetical discovery for purposes of ultimate commercial gain.

Such books, as might be expected, make their appearance more frequently in the United States than in Great Britain. For the genetical worker over there is generally supported by State funds, and naturally feels called upon to satisfy the clamour of democracy that it is getting its money's worth. Dr. Jones's book (1) on "Genetics in Plant and Animal Improvement" is a very favourable specimen of its class. It is clearly and interestingly written by one who has served a sound apprenticeship in research, and at the same time is

evidently in close touch and sympathy with the practical man. The author has a double qualification for writing the book he set out to write, and he has used those qualifications well. Especially good is his account of hybrid vigour and of the effects of inbreeding, as indeed might have been expected from one who is an acknowledged authority on these matters. Altogether the book should prove of high value to the considerable numbers of those whose teaching or practice concerns the betterment of domesticated animals and plants. At the same time, those whose interest in genetics is purely scientific will appreciate the freshness and sincerity of the author's account, and should gain not a little of value from the volume.

Though Dr. Jones deals ostensibly with the improvement of animals as well as of plants, it is chiefly from the latter that his illustrations are taken. Indeed, when dealing with animals he is apt at times to be misleading. Thus he points out justly that a population of self-fertilised plants, no matter how heterozygous to start with, tends with each generation to become more and more a collection of homozygous individuals—as was argued long ago by Mendel himself. But he then goes on to suggest that if a herd of Shorthorn cattle consisting of reds, whites and roans, were inbred, it would come to consist of reds and whites only (p. 333). The paragraph is puzzling, for surely Dr. Jones cannot believe that Shorthorns are self-fertilised! Possibly he is conscious of limited experience in animal genetics, since in his preface he suggests that his book should be supplemented by Prof. Winters' book (2) on "Animal Breeding," which is published in the same series. This is a pity, because Prof. Winters' book is about as poor a production as Dr. Jones's is excellent.

Prof. Winters has quite failed to grasp the significance of modern genetical discovery. He still talks about three distinct types of inheritance, Mendelian, blending, and prepotent; he refers to Galton's law of ancestral heredity as "one of the greatest, if not the greatest, of the practical contributions of biology to animal breeding"; and he attempts to measure the relationship of animals in terms of "blood," as they used to do before the science of genetics was invented. With these notions as a foundation, it can be understood that when the author comes to discuss such topics as inbreeding, crossbreeding, and selection, he is neither clear nor stimulating. For the rest, the book is of the "scissors and paste" type, lacking that unity of presentation which comes of sound and critical thinking.

(3) It is a relief to turn from it to Dr. Crew's "Animal Genetics." In writing this book Dr. Crew, a scientific worker, has his eye on the practical breeder most of the time. He wishes to enlist his sympathies in the direction of mutual co-operation which shall

be helpful to both. He fully realises the impertinence of suggesting that the breeders of such stock as grace the show-yards of Great Britain do not know their business, and that it is for a geneticist to put them right. Nevertheless, he is aware of the mistakes that do not figure in the show-yard, and he feels that even in the light of present knowledge some of these could be avoided. With fuller knowledge would come greater certainty in getting the right animal; but the acquisition of that knowledge means the co-operation of the breeder, and the first step is to stimulate his interest. So Dr. Crew has written his book "in order to provide the breeder with a brief account of what has been and of what is being done by the geneticist," and it says something for the progress of research in animal breeding that he has been able to give a clear account of the process of heredity in its widest sense without having recourse to illustrations from the plant world.

Dr. Crew's book falls roughly into three parts, dealing respectively with the general mechanism of heredity, with the peculiar problems associated with sex, and with various special topics, such as prepotency, inbreeding, selection, sterility, etc. As might be expected, Dr. Crew is at his best in the part relating to the special problems of sex, such as are conveyed by the terms hermaphroditism, sex-reversal, intersexes, and the like. We do not know of any better general account of these phenomena. The workmanship is sound throughout, the material thoroughly up-to-date, and the book conveys the impression of having been written by a man who knows what he wants to say and goes straight to the point. The author has managed to pack an astonishing amount of stuff into a relatively small space, and this condensation does not always make too easy reading. However, the matter is always clear, though there are places where the reader must be prepared to make an extra effort. It can be safely said that there is no better book on animal genetics, and its excellent bibliography should prove invaluable alike to the student and the teacher. Whether it will greatly influence the present generation of stock-breeders is very doubtful, but if it succeeds in capturing the imagination of the younger generation it will have gone far towards achieving Dr. Crew's primary object.

(4) To pass from Dr. Crew's book to the stately volume wherein Dr. Hurst has enshrined his "Experiments in Genetics" is to pass from the atmosphere of a busy modern city to that of a quiet country town. In it Dr. Hurst has collected together and reprinted a series of papers dating back to the 'nineties of last century. His choice of material for experiment shows remarkable versatility, including, as it does, orchids, rabbits, poultry, peas, horses, pigeons, and snapdragons,

while some of the most interesting papers deal with original data on the inheritance of eye colour, musical ability, and other human characteristics. The reader will find here little or nothing concerning the later developments of Mendelism, whether of linkage, or non-disjunction, or lethal factors, yet those papers which deal with animals will probably appeal much more to the practical breeder than Dr. Crew's more scholarly account. Dr. Hurst makes heredity look very simple, perhaps too simple for the critical mind, and he presents his facts in a manner that can be readily grasped by the average untrained intelligence. Having started, too, as a practical horticulturist, he instinctively keeps the breeder's point of view in mind, and he has an eye for telling examples. In so far as science goes, the breeder must be taught to walk before he can run, and we believe that a stimulating elementary booklet on animal breeding could be culled from the contents of this rather ponderous volume. In any event, Dr. Hurst has conferred a boon on the geneticist who wishes to consult him by bringing together papers scattered in a number of different journals, some of which are not always easy to obtain.

Science in the Past and Future.

- (1) *A Brief Outline of the History of Science.* By J. G. F. Druce. Pp. iv+151. (London: The Chemical News, Ltd., 1925.) 5s. net.
- (2) *A School History of Science.* By J. A. Cochrane. Pp. 144+8 plates. (London: Edward Arnold and Co., 1925.) 2s. 6d.
- (3) *Paris: or, The Future of War.* By Capt. B. H. Liddell Hart. (To-day and To-morrow Series.) Pp. 92. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1925.) 2s. 6d. net.
- (4) *The Future.* By A. M. Low. Pp. ix+203+8 plates. (London: George Routledge and Sons, Ltd., 1925.) 5s. net.

THERE are vogues in scientific literature as in other activities. There is evidence at the moment of an increasing interest both in the scientific past and in speculations as to what the future holds for us. As to the former, the influence of a new spirit of humanism in scientific teaching has brought into being on the theoretical side a History of Science Society in the United States, the membership of which extends to most European countries; and on the applied side we now have in England a flourishing, if young, Newcomen Society with a growing American branch. The movement, too, has spread to the universities. London has its new M.Sc. degree in the history and method of science, whilst many other universities, both in Europe and the United States, include various courses of lectures by eminent scholars upon

different phases of the history of science. Naturally this new spirit has found its expression in literature. For some years now there has appeared a succession of books dealing with special and general historical studies in science. The specialist, the general reader, and the schoolboy are all being catered for.

What is the significance of this new tendency? The War had undoubtedly something to do with it, though it was not responsible for its initiation. The pioneers of the new movement were certainly pleading before 1914 for the breaking down of the barriers between science and the humanities. The intensive part played by applied science in the War has, however, brought widespread attention to many new problems. Whither are we tending? What has the future in store for us? The pace of scientific research is so rapid, inventions carrying with them revolutionary possibilities in our everyday lives crowd in on us with such persistence, that it is but natural to find the intellectual public a little bewildered and vaguely uneasy as to what lies ahead. It is still a vivid memory that eight million lives were lost between 1914 and 1918. Nor can the aftermath of the economical and political upset of values, and the new difficulties of life and livelihood resulting therefrom, do other than accentuate this natural tendency to speculation as to what is to confront civilisation in the years to come. Here again we meet problems that have found an outlet in a flood of literature of which the "To-day and To-morrow" series issued by Messrs. Kegan Paul is an example.

Very properly, the studies of "yesterday" and of "to-morrow" are related. We are past the stage when history was regarded as a mere enumeration of facts and dates. The problems of the future are the better considered in the light of the lessons of the past. This is particularly true of the history of science, in view of the inevitable bearing scientific progress must have, not only upon the methods of mechanical routine of the future as a result of the multiplicity of inventions yet to come, but also upon the more disciplined and ordered ways of thinking out social problems of peace and war on the part of the populace in general.

It is appropriate, therefore, that of the four volumes before us, two deal with the past and two with the future.

(1) Dr. Druce has undertaken a formidable task in essaying even a brief history of science within the limits of 140 pages. Such a work can only be successful if it frankly confines itself to the broader movements of scientific history at the expense of any details that are not relevant to the main purpose. Proportion is everything. From this point of view, Dr. Druce's

book shows many weaknesses. The influence of Greek science for many centuries was essentially due to the teachings of Plato, Aristotle, and Ptolemy, and it would have been better to enlarge upon these influences at the expense of the many other lesser Greek philosophers who in fact find prominence in this book. Ptolemy is dismissed with six lines on page 18, whilst on page 40 his theory is merely referred to as having involved "cumbersome assumptions." The chapter on Roman science is also unsatisfactory. It is largely confined to the Julian Calendar, to Galen, and to the metallurgical sections of Pliny. The wider aspects of contrast between the Greek and Roman attitude towards science are ignored, whilst the influence of Seneca, de Varro, and Vitruvius is not even mentioned. The best portions of the book, probably because the author is a chemist, are those dealing with the growth of chemical science. The book is well indexed and a bibliography is added.

(2) Mr. Cochrane's is a book of an entirely different kind. Its title is somewhat misleading in that it is not so much a connected narrative as a series of biographies of men of science. It is intended for school-boys and girls and is very interestingly written. Part I. deals with the ancients, Part II with physicists, and Part III. with chemists. As a stimulant to more serious study it should serve its purpose well.

(3) Of the remaining books, "Paris" is a thoughtful essay on the future of war. Capt Liddell Hart attacks the current theory (a transmission to modern militarists of the teachings of Napoleon and Clausewitz, and involving in its application the dogma of the "nation in arms") that the national goal in war can be attained only by mass destruction. Such a theory carries its own penalties. "Of what use," asks the author, "is decisive victory in battle if we bleed to death as a result of it?" He states that the true aim of a nation at war is "to subdue the enemy's will to resist with the least possible human and economic loss to itself." From this point of view, Capt Hart surveys the future rôles of air, land, and sea forces in relation to civilian and economic considerations as much as to the enemy's military forces. The author's point of view is well summarised in his closing lines. "Weapons, target, and aim will alike be civil. The future of war lies in the future of peace."

(4) Finally, we have Mr. Low's very interesting vision of the future in the light of scientific progress. It is indeed an encyclopædic vision. Within 200 pages we are hurried breathlessly through the whole gamut of the activities, habits, comforts, practices, and modes of thought of the human being and what is to become of them all. We have referred to the work as an encyclopædic vision; we might almost have called it

a catalogue of future possibilities. Sound and silence, artificial light, planet communication, transport, wireless, sport, clothes, marriage and love, warfare, politics, art, crime, the occult—all these are here, and much more. Mr. Low may or may not be right in many of his forecasts, but neither to the man of science nor to the man in the street is it sufficient to tell the "what" of the future and to omit the "how" and the "why."

I. B. H

Devolution in the Modern State.

A Grammar of Politics. By Harold J. Laski. Pp 672 (London: George Allen and Unwin, Ltd., 1925) 18s. net.

MR. LASKI has produced what is certainly the most comprehensive book on political theory that has appeared since the War. Written with all the knowledge and more than the authority displayed in Mr. Laski's earlier works, it is at once more human and more entertaining. Essentially moderate both in statement and suggestion, it insists on the difficulty of modern politics and scorns short cuts to the millennium as cloaks to disguise poverty of thought and devices to serve the ends of rhetoric; yet it succeeds nevertheless in conveying an urgent sense of the gravity of the situation.

A large part of the book is devoted to showing how political institutions such as the British Parliament are used as the instruments of the classes that have successively dominated them. A hundred years ago in England the landed class was dominant, and legislation reflected its interests; in the middle of the century the new property class, born of the industrial revolution, succeeded to power, and the doctrine of *laissez faire* with its corollary of unrestricted competition in the economic, and refusal of State action in the political field, gave countenance and support to the vast acquisitions of private wealth. Mr. Laski is particularly severe in his criticism of the social effects of the dominance of this class, effects from which we are still suffering:

"The commodities and services necessary to the life of the community are never so distributed as to relate to need or to produce, a result which maximises their social utility. We build picture palaces when we need houses. We spend on battleships what is wanted for schools;" and of the effect upon the governing class itself he writes. "Men may begin to acquire property to safeguard their lives from want, but they continue to acquire it because of the distinction which comes from its possession. . . . It enables them to attune the will of society to their own."

The phase of the propertied interests is, however, in Mr. Laski's view, passing away in its turn, and the

desire of the masses for a better standard of life, better houses and more education, though dimly and intermittently expressed, is beginning increasingly to set the direction of political activity. How far can the State secure the satisfaction of these demands? How far, in other words, is the popular remedy of Socialism adequate to the nation's needs?

Here Mr Laski grows cautious. Like so many modern writers, he has an almost temperamental hostility to the State, and is far from wishing to see men's lives regulated by an increasing measure of public control. Reacting strongly against the Hegelian conception, Mr. Laski regards the modern nation State as by no means a final form of organisation; it is just one of the number of groupings into which mankind happens to have arranged itself, and it is becoming a question how far this particular form of grouping is best adapted to the changing needs of men.

In the last resort Mr. Laski seems to regard the State as an organisation largely federal in character. It is a complex of different organisations formed to carry out special purposes, and whatever authority it possesses must be based upon and drawn from them. Sovereignty in the modern State should be neither absolute nor uniform; it should, on the contrary, be distributed among a number of different bodies, on the principle that the right to make decisions should be vested in the interests chiefly affected. This means

"making the mining industry a unit of administration in the same sense as Lancashire. It means the abandonment of the sovereign State, in the sense which equates the latter with society and gives it thereby the right to dictate to associations within society."

This plea for devolution is all to the good.

The chief defect of the modern State is its size. So vast is the stage upon which the drama of politics proceeds, so interwoven the complex strands which condition events, that the State assumes increasingly the aspect of a mechanism, while the procession of events gives countenance to a determinist attitude, if not to men's lives as individuals, at least to their affairs when taken in the mass. What happens in society seems less the result of human will and foresight, the embodiment of purpose and the effect of guidance, than the mechanical resultant of the interplay of forces the genesis of which escapes detection and the workings of which evade control. In such a society the individual feels helpless, he obtains the impression that he does not count, and that his will cannot be made to matter. From this sense of helplessness springs a political apathy, which tends to regard politics as a professional preserve with which the ordinary man has no concern, because its concern is so obviously not with him.

Hence arises the paradox that amid all the forms of democracy man is as helpless as he ever was; though the battle of freedom has been won in theory, it still remains to give it effect in practice. "We still need to know," as Mr. Laski puts it, "what working hypothesis it involves and what institutions can effectively embody its purpose."

The conclusion at which Mr. Laski arrives is that the way to revive man's interest in politics is by taking a smaller unit for governmental purposes wherever a smaller unit is practicable. Different units are practicable for different purposes. Mr. Laski, cautious as ever, is by no means a wholesale devolutionist. "It is practicable to allow a town to decide for itself whether it wants municipal electricity; it is not practicable to allow it to decide whether it wants an educational system." Subject to provisos of this character, functional devolution and territorial decentralisation are recommended, because they create a corporate sense of responsibility, train men in self-government, and confide "the administration of powers to those who will feel most directly the consequences of those powers."

This book is a profound—in some ways it is a great—work; at times witty, at others learned, at others expository, at others a little dull, it rises to a nobility of outlook and an eloquence in expression which distinguish it as perhaps the finest contribution to the political thought of our times since Mr. Graham Wallas wrote "The Great Society." C. E. M. JOAD.

Our Bookshelf

The Outline of History: a Plain History of Life and Mankind By H. G. Wells. New edition, fully revised (Complete in 24 fortnightly parts) Part 1. Pp. 32 Part 2. Pp. 33-64. (London: Cassell and Co., Ltd., 1925.) 1s 3d. net each part

MR WELLS's world history was first written in 1918-1919 and revised in 1920 and 1923. Even in the short period which has since elapsed, discoveries of new material have been made in almost every part of the world, and, whether by accident or by design, new evidence is being brought to light almost daily which bears upon the early history of man upon this globe. It is, therefore, no matter for surprise that Mr. Wells, in preparing the new edition of his "Outline of History," should have found it necessary not merely to recast, but to rewrite a considerable part of it, especially in the earlier sections. It is inevitable that a work of this kind should be at the mercy of any new discovery which may at any moment throw doubt on a conclusion or necessitate a change in point of view. Mr Wells has done his utmost to protect his readers from this danger by bringing his information fully up-to-date, and even so recent a discovery as that of the Galilean skull receives due mention.

The first two parts which have now been issued afford

an opportunity to test the quality of the work in its new form. They comprise from the beginnings of the earth down to Neolithic man in Europe, ending with an account of primitive trade. This, to many, will be the most interesting section of the whole work, as it deals with the earliest stages in the evolution of animal and human life and embraces so much that is new. It is inevitable that a writer of such strong individuality as Mr. Wells should at times run counter to accepted views; but he is always prepared to argue his case on good grounds. His dates for the late stages of the Palæolithic period on some views may appear too high, but this is of little moment beside the great advantage which his time charts and scales confer on the reader who is not an expert. To such a one they will be invaluable as an indication of perspective.

A special feature of this edition is the illustrations, which have been greatly increased in number and chosen with much discrimination and care.

Der Schadel des eiszeitlichen Menschen von Le Moustier in neuer Zusammensetzung. Von Dr. Hans Weinert. Pp. vi+54. (Berlin: Julius Springer, 1925.) 6-60 gold marks.

IN 1908 the skeleton of a young man of the Mousterian or Neanderthal race was discovered by Otto Hauser in the lower cave of Le Moustier, in the Dordogne, and it was eventually purchased by the Museum für Völkerkunde in Berlin. The specimen seems to have been disinterred without sufficient skill, and the skull was broken into many fragments. It was first studied by the late Prof. H. Klaatsch, who reconstructed the skull without much success. This reconstruction was improved in two later efforts in the Berlin Museum. A final attempt has now been made by Dr. Hans Weinert, in the light of the latest knowledge, and the result is described in detail in a small volume just published in Berlin. The work is beautifully illustrated with both photographs and diagrams, and includes an exhaustive revised table of measurements.

The new reconstruction of the facial bones seems to have been rendered difficult by the breaking of the edges of the fragments during previous efforts. Dr. Weinert, however, with the aid of Prof. W. Dieck, who arranged the dentition, has now produced a face in conformity with other known examples of Mousterian man. The lower jaw is wider than in the previous reconstructions, and all the contours now agree well with those of the other skulls. The Le Moustier individual, if he had survived to maturity, would doubtless have had a skull essentially identical with that of La Chapelle-aux-Saints. Dr. Weinert concludes that he was probably contemporary with the latter, and finds no evidence to support the view of Klaatsch that the one is of greater geological age than the other.

A. S. W.

The Anthocyanin Pigments of Plants. By Muriel Wheldale Onslow. Second edition. Pp. viii+314. (Cambridge: At the University Press, 1925.) 21s. net.

AFTER very favourable comments in these columns (vol. 99, p. 261, 1917), a good reception and nine years of support, the first edition is now replaced by a second containing all the admirable qualities of its

predecessor. The accumulated findings of investigators in this period are incorporated in its text, and its admirable bibliography in consequence includes more than 200 new references, carefully chosen and critically summarised, so as to avoid, on one hand, omitting useful publications, and on the other, to guard against undue increase in size. The general arrangement is unaltered, and the new contributions are mainly to be found in those chapters dealing with the chemistry and biochemistry of the subject and in those on genetics, these latter being extremely numerous, but many of them not of fundamental importance.

The new edition serves to emphasise the fact that, in spite of advances into the chemical constitution of many anthocyanins, we are by no means clear as to the reactions involved in their origin, or as to the relation between their chemistry and their Mendelian factors. If the book were to serve no useful purpose other than this, it would still have done enough to compensate for the labours involved in its preparation.

Brazil after a Century of Independence. By Herman G. James. Pp. xiv+587+8 plates+3 maps. (New York: The Macmillan Co., 1925.) 17s. net.

THERE was room for a comprehensive work on modern Brazil in spite of the many volumes on Latin America which have appeared in recent years. Mr. James has produced a well-balanced volume, appreciative but yet critical, and written from the point of view of the student and not the globe-trotter or financier. It contains much of scientific interest, and has a useful physiological introduction, which books of this nature too often lack. Special attention may be directed to the chapters on natural resources, agriculture, and transportation. In the chapter on population and vital statistics, we miss a discussion of the relative birth and death rates of the various immigrants and the adaptability of various races to the climatic and other conditions. No mention appears to be made of the Japanese, of whom there are now more than 25,000 in Brazil. The three maps are clear and useful, but scarcely adequate to a volume of this scope. The illustrations are few and of little interest.

L'Industrie des cyanures. Par P. Brun. (Encyclopédie scientifique: Bibliothèque des industries chimiques.) Pp. x+469. (Paris: Gaston Doin, 1925.) 20 francs.

THIS volume, which deals very fully with the various industries connected with cyanide production and utilisation, is divided into three sections: theoretical, industrial preparation, and finally, applications of the cyanides to various industries. The main section (2) is devoted to the extraction of the material from industrial residues and synthetic preparation.

A useful feature is the inclusion of lists of the patents and authors quoted in the text; its usefulness would have been still further increased if a reference had been given to the page on which they were described. It is unfortunate that the book is not provided with a suitable index. An interesting chapter is devoted to the toxicological effects of hydrocyanic acid and potassium cyanide and the researches on these poisons.

The volume is a useful addition to the literature of chemical industries.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.

The Production of Oysters (*O. edulis*) on English Beds in Relation to New Observations on Breeding Phenomena.

THE present shortage of oysters (*O. edulis*) on all English, and apparently most European, beds is a suitable occasion to press for improved methods of production. The depleted state of the beds can be ascribed to an unusual mortality in 1920 and 1921

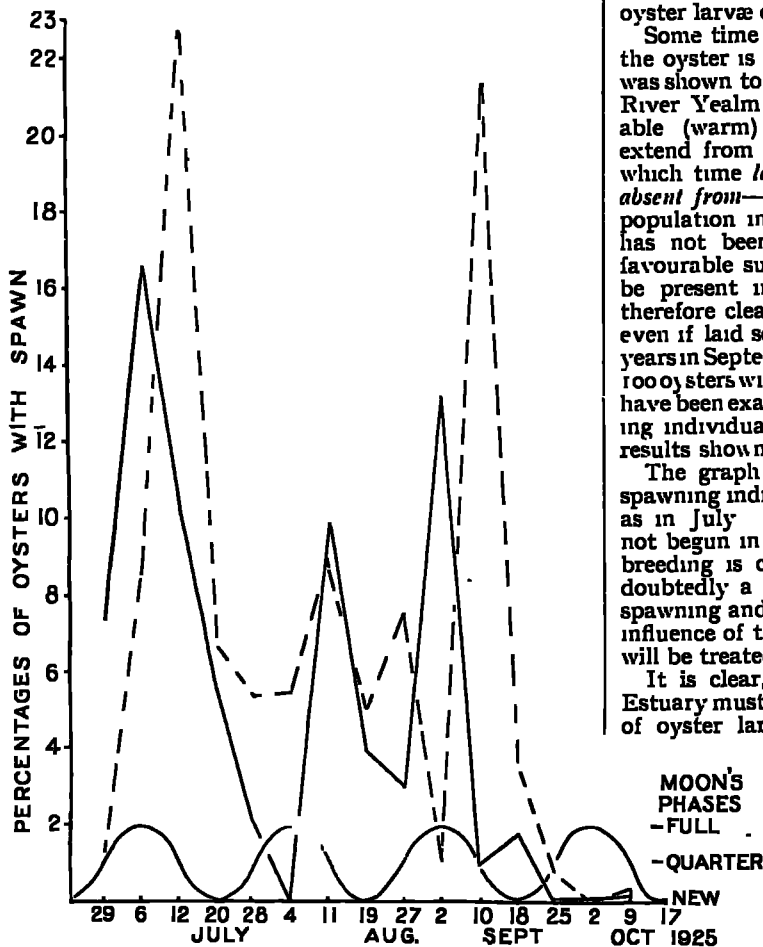


FIG. 1.—Graphs showing the weekly percentages of oysters, with good shell-growth carrying embryos or larvae in relation to the moon's phases from the Truro oyster beds (Fal Estuary) in July-October 1925, indicating an irregular correlation between lunar periodicity and breeding phenomena.

The continuous line graph shows oysters carrying embryos of an age upwards to about two days.
The dotted line graph shows oysters carrying embryos mainly fully shelled or older than about two days.
The continuous curve shows the moon's phases from Admiralty Tide Table data.

and the comparatively low yield of spat since 1921 owing to the poor summers. The spat-fall for 1925 is as yet scarcely determinable in the ordinary course of practical work. It is probably accurate to state that the majority of the oysters living on English beds in 1924 and 1925 were spat (that is, settled from the free-swimming larvae) in 1921.

The chief method of catching—or rather obtaining—oysters in England is that of scattering clean shells

or laying tiles on the oyster beds in the early summer, at the time the earliest batches of larvae are judged ready to settle down from the free-swimming stage; in some localities the beds are also harrowed whereby buried shells may be turned over so that the soil can be washed off the recently embedded shells by the tidal current and a clean surface obtained in that way for the settling larvae. Harrowing is also said to improve the growth of the older oysters. The clean shells, or cultch, are generally put out in mid-June, but may not be put out until a few weeks later if the summer is a late one and the oysters thereby delayed in spawning. The principles on which cultch is laid are that the oyster is an early summer spawner, that early spat grow to a larger size than late ones, that spat settle in numbers only in the warmer weather (when the temperature of the water is about 64° F.), that the surface on which the oyster larvae can settle should be clean.

Some time ago the present writer pointed out that the oyster is a summer breeder (J. M. B. A., 1920) and was shown to breed from June until September on the River Yealm close to Plymouth Sound. In favourable (warm) summers, however, the period may extend from late May until October, during most of which time larvae are constantly present in—or rarely absent from—the sea, being emitted from the parent population in batches. The significance of this fact has not been grasped by oyster-producers. In a favourable summer, oyster larvae may be assumed to be present in the water all through the summer, therefore clean cultch may be expected to catch spat even if laid so late as August, or even in very warm years in September. During the past summer batches of 100 oysters with good shell-growth from the Fal Estuary have been examined weekly for the percentage of breeding individuals—amongst other characters—with the results shown in the accompanying graphs in Fig. 1.

The graph shows at once that the percentage of spawning individuals was almost as high in September as in July. Unfortunately the work this year was not begun in May. The rhythmical character of the breeding is clear from the graph, and there is undoubtedly a closer—but irregular—relation between spawning and the full moon than with the mere tidal influence of the moon, but this aspect of the problem will be treated more fully later.

It is clear, however, that the waters in the Fal Estuary must this year have borne an enormous amount of oyster larvae, since from July 1 until September

23 there was a weekly average of the oyster population with seven per cent. containing mature or nearly mature larvae ready to be shot or being shot into the water. There is every reason to believe that the breeding conditions on other beds were similar to those on the Fal, and yet oyster-producers rely for their catches on cultch laid about June. Indeed, on the public oyster beds in the Fal Estuary, the amount of cultch laid was almost negligible for the fine stretch of ground available, and it is probably true that oysters to the value of thousands of pounds have been lost to

that fishery for the years 1928–30 from this omission. Probably no particular body or individual is responsible for this omission, but there is no reason why it should recur.

During the course of other investigations, the writer has conducted definite experiments on catching late spat, which give point to the remarks made above. On August 4, 1923, clean shells were put into the sea—long after the normal cultch had been put out—and

caught spat which grew to a size of only $\frac{1}{8}$ to $\frac{1}{4}$ inch by October 22, but in July 1924 these tiny spat had grown to well-shaped brood oysters $\frac{3}{4}$ to more than one inch in length and depth, while a few Portuguese oysters were obtained in the same experiment with dimensions $1\frac{3}{4}$ by $1\frac{1}{4}$ inches in a period of eleven months. Definite experiments made in early August 1924 showed that oyster spat were still settling in the sea at that time. In July 1924 fresh clean shells amounting in number to 1373 in various experiments were put in the sea for the purpose of catching spat. Rather more than 50 per cent. of these shells caught one or more spat; one shell caught 10 spat, and shells with 3 to 6 were not uncommon, and it is probable that only a small percentage of these spat would have been caught on cultch laid earlier. In July this year these year-old young had attained a size up to $1\frac{1}{4}$ inches and a beautiful normal shape. Cultch can, therefore, be laid with profit late in the season even in a poor or normal summer, whereas in a long warm summer it is probable that the yield of spat might be increased two- or three-fold over and above the larger increase due to the warmer summer. In the warmer waters of the southern European beds, a late summer laying of cultch might often be as productive as an early summer laying and result in doubling the production of oysters.

In oyster production, as in many other cases, success is accumulative, for the addition of young oysters to the beds soon increases the amount of larvæ set free in the water, as the following observation proves. On July 21 this year, 100 young oysters from the River Blackwater in their third summer (*i.e.* aged mainly about two years), and of an average length and height of only 40 by 42 millimetres (1.57 to 1.65 inches), yielded 10 individuals with embryos or larvæ within the shells, and 10 ripe females ready to spawn. In these spawning young, however, the number of larvæ produced is relatively small compared with the number produced by larger oysters, comparative figures will be given later.

Until the artificial production of oysters is established on an economic basis, and it will be many years before this desirable end is attained—though the proof given above that oysters breed in quantity throughout the summer will enable experiments on spat-catching in tanks to be carried on over a much longer period than at present and perhaps hasten success—it is important that more attention should be paid to improved methods of catching oyster-spat in the sea. The laying of clean shell, shown above to be economically effective even late in the year, may not in itself be the best means of increasing the stock of young oysters, and the problem may easily be one in which the naturalist can be a real help to the oyster-fishery in general.

Acknowledgment is due to the Truro Corporation for supplying the oysters for the observations on spawning, to the Tollesbury and Mersea Native Oyster Co. for the many facilities afforded for experimental work on their excellent grounds, and to Prof. Awati for valuable assistance at Mersea during July.

Marine Biological Laboratory,
Plymouth, October 13.

J. H. ORTON.

Ethics of Birth-Control.

As a constant reader of NATURE I should be very grateful if you will allow me to make public one or two criticisms of the review by Prof. J. S. Huxley of "The Ethics of Birth-Control," published in the issue of September 26.

One of the greatest societies ever known upon our planet, the Catholic Church, has denounced artificial

birth-control as immoral, simply on the ground that it is against the natural law or our "human dignity." This surely is interesting from a purely scientific point of view, since the Catholic Church is composed of men of many nations, and is therefore more representative of human nature than the British "Special Committee of the National Council of Public Morals," the report of which is under discussion. I mention this in passing, in order to show that Canon Lyttelton is really representative of a strong and by no means negligible body of human opinion.

The reviewer objects to the use of the word "unnatural" as applied to birth-control. Moral theologians have adopted the use of the terms natural and unnatural to distinguish two kinds of vices. If an action is performed in the proper or natural way, but contrary to the moral law, as in fornication, it is said to be natural. If it is performed in a manner contrary to nature, as in masturbation or sodomy, it is said to be unnatural. Contraception is rather to be classed among the unnatural vices, because the natural purpose of the marriage act is deliberately frustrated.

The argument based on the use of food is constructed in the defiance of logic. The parallel between eating and the act of generation is perfectly legitimate, but leads logically to precisely the opposite conclusion. Eating is primarily intended to sustain life, and there is a natural pleasure in it, which may be quite legitimately enjoyed. The act of generation is primarily intended to bring forth life, and again there is a natural pleasure attached to it. The decadent Romans, who ate and drank merely for the pleasure of it and deliberately vomited that they might begin all over again, were indulging in an unnatural vice of gluttony; and no sane person would attempt to justify their worse than bestial conduct. How far do those fall short of a similar condemnation, who indulge in the pleasure of the marriage act and yet deliberately frustrate its primary purpose?

Lastly, the reviewer quite gratuitously criticises the Middle Ages. He says "The over-concern of the individual for the salvation of his own soul was a characteristic of the Middle Ages." Someone, a great while before the Middle Ages, had said "What shall it profit a man, if he gain the whole world and suffer the loss of his own soul?" It is interesting to find the Medieval Church so thoroughly Christian!

I apologise, Sir, for the length of this letter. But it seems only fair that so important a question should be seen in more than one light. If the illogical character of the reviewer's reasoning is not at once evident to his readers, his review must give the impression that contraception is necessarily approved by all scientists and reasonable men. This is far from being the case.

GREGORY SWANN, O.S.B.

Ampleforth Abbey, York.

October 16.

FATHER SWANN's letter deserves a reply. (1) The whole of his argument as to whether birth-control is natural or unnatural (I gather it is in either case a vice!) depends on the prior assumption that the *sole* "natural purpose of the marriage act" is procreation. There are, however, a large number of people who would deny this, and say that its natural purpose (or better function) is dual—not only procreation, but also the increase of marital love and joy.

The great point of fact is that there is, *increasingly* with increased infant welfare and increased pressure of population, a large disharmony between the frequency of the nuptial act required for a sufficient family—say three to five children—and that which

is a satisfaction, on the most restrained and moderate scale, of our "natural" normal and healthy instincts. I still maintain that it is impossible to say whether the production of a family or the reasonable satisfaction of the sexual instinct is more "natural," in that this term merely introduces confusion into the question. There still seems to linger in some quarters the idea that the sexual act is *per se* evil.

In any case, it appears to me to be very dangerous ground for a representative of the Catholic Church to denounce contraception as unnatural while the same Church sanctions what the average man would regard as equally or more unnatural, namely, *coitus reservatus*, as a way out of the difficulty. It also sanctions intercourse during the (so-called) "safe period," which also, if I understand Father Swann, he would call unnatural (provided it were really "safe").¹ In any case, as shown clearly by Dr. Stopes ("Wise Parenthood," p. 55; and "Contraception"), union during this period is for most women definitely "unnatural."

(2) I will not waste space with comment on Father Swann's criticism of my analogy from food, save to say that if we only ate in order to sustain life, the most modest dinner-party would be excessive. And that his remarks on the ancient Romans and the *vonitorium* are off the point. The moral need for restraint remains whether one practises artificial birth-control or no, and whether one enjoys one's dinner or no. To assume that contraception must mean excess is a mere insult to those who practise it.

(3) As to the individual's concern for salvation, I was merely attempting to show that it could be pushed to too great lengths, which is undoubted. The same authority quoted by Father Swann also made a remark to the effect that those who lost their life should find it. Those who are over-concerned about their individual souls do not "lose themselves" in this way.

J. S. HUXLEY.

October 21.

The Anti-trade Winds.

IN the article published in NATURE of July 18, p. 115, I am glad to see that Mr. L. C. W. Bonacina is in conformity—at least in a general sense—with my views upon the question of the anti-trades. I do not know the opinion of European meteorologists exactly in regard to the *fixity* of these currents; but if we examine books as those of Ferrel, Dove, Angot, etc., it seems that the existence of the anti-trades is a well-recognised fact. The evidence, however, is not clear; on the contrary, the facts seem to be against that theory. I find very much justified the remark of Sir Napier Shaw (Quarterly Journal of the Meteorological Society, January 1925) that he had "never been really able to prove the existence of an anti-trade over the region between anti-cyclones and the equator."

Do the south-west or westerly winds extend over the limits of the equator? I think they do not. Besides the observations of Bogota, those of Pasto in South Colombia (Lat. $1^{\circ} 31' N.$), at the height of 2595 metres, show that the high winds blow from east and south-east.

The directions of the dust of volcanoes are frequently said to prove the existence of the anti-trades. As I wrote in the U.S. *Monthly Weather Review*, December 1923, the volcanoes Cotopaxi at Quito and Colima in Mexico do not prove the existence of such winds.

I know that Mr. Bonacina refers to mean condi-

tions in the use of the terms *trade* and *anti-trade*. I do not see any objection in the use of the *trades*. They blow in the Atlantic quite constantly, but not so the anti-trades. My opinion is that the atmospheric circulation, as developed by Thompson, Ferrel, etc., is not in accord with observed conditions in tropical and equatorial countries.

S. SARASOLA, S.J.

Observatorio Nacional de San Bartolomé,
Bogotá, September 11.

FATHER SARASOLA's observations are certainly out of harmony with the older ideas about the general circulation of the atmosphere as due to Ferrel, Dove, and others, but these are not nowadays accepted as anything more than a rough approximation, and the observations, in fact, lend most valuable local support to more recent views, according to which over the equatorial limits of the north-east and south-east trades the average direction of the wind is respectively south-east and north-east, becoming south-west and north-west respectively above the polar margins of the trades. A scheme involving this disposition of the anti-trades was, as I indicated in the article in NATURE of July 18, put forth by Blair (*Monthly Weather Review*, 1916), and various upper air observations in different localities certainly support it. In the vicinity of the Cape Verde Islands, lat $16^{\circ} N.$, the "anti-trade" is, I believe, south-east, in conformity with the observations in Colombia, whereas in the vicinity of the Canary Islands in lat $28^{\circ} N.$ it becomes south-west. In a report of upper air observations at the Apia Observatory, Samoa ($14^{\circ} S.$), during 1923-24, the anti- or counter-trade is very definitely established above the south-east trade, its base being between the altitudes of three to five miles according to season, the direction being north-east below and changing through north to north-west above.

It may, therefore, be suggested that, corresponding to what happens over the south-east trade in Samoa, the south-westerly wind may yet, with further observations, be found in Colombia above the southeasterly wind found by Father Sarasola overlying the north-east trade—which south-westerly wind would gradually descend with increasing latitude towards the polar margin of the north-east trade. It must, further, not be forgotten that the northern trade system is much upset by the monsoons, being locally subverted in summer, and reinforced in winter, and if the north-east trade is variable locally as regards regularity and other features, it were only to be expected that the counter-trade would be so too. But I fail to see that there is any evidence for doubting the existence of the "anti-trades," at all events, in a statistical sense, and theory surely necessitates some kind of average counter-flow *away* from the equator to balance the statistical "trades" *towards* the equator.

Much of the difficulty which appears to exist about "trades," "anti-trades," "westerlies," and other *stereotyped* winds, as items in the general circulation of the atmosphere, undoubtedly turns upon the matter of definition. Any one who tries to frame an exact definition of a "trade," etc., to be applied to the actual currents of the atmosphere will soon discover that "trades," "anti-trades," and so forth, are really statistical abstractions, artificial categories, indispensable in enabling us to form a mental picture of the mean or average structure of the circulation, but a fatal snare the moment we lose sight of the fact that this statistical picture of the circulation represents not a fixed static system, but one in a perpetual state of perturbation—of distortion and subversion

¹ I quote from "The Morality of Birth Control," by 'A Priest of the Church of England,' London, 1924.

of the average structure so depicted. It is not so much meteorologists dealing with day-to-day weather as geographers approaching meteorology through climatological normals that are liable to fall into the trap, but in any case it is time that the subject of "trades," etc., in text-books both of meteorology and physical geography, were presented in a manner more calculated to make the student think in terms of the *perturbability* rather than the *fixity* of the great wind-belts of the globe. Suppose the actual daily circulation, the interchange of air between the equator and the poles, did conform to anything resembling the cast-iron statistical model, what would be the result? All weather changes, as we know them, would cease, some regions would absolutely never see rain at all, others would literally never be dry, whilst in England, to judge from conditions when the actual distribution of wind and pressure *does* momentarily coincide with the statistical picture, we should have almost constant cloud and drizzle.

This is no doubtful inference; it is in absolute accord, not merely with common experience of daily weather sequences, but also with the principles of the modern theory of the Polar Front. Sometimes when a great wall of high pressure westward of Ireland interrupts our "westerlies" there occurs something which any one whose mind was fettered by the statistical picture would never allow for, namely, the passage of a northerly current all the way from the Arctic to the tropics, and current in sub-tropical latitudes has, so far as I can see, as much right to be called a "trade" as the shorter equatorward current prevailing when the controlling anticyclone takes up its more usual position about 35° N. The number of distortions, minor and major, of the mean or average statistical picture is such that there is no criterion for deciding in all cases whether a particular current of air is, or is not, a "trade," or "anti-trade," as the case may be.

L. C. W. BONACINA

October 20.

Weather Prediction from Observations of Cloudlets.

THE simplicity of the following method of weather prediction is liable to excite incredulity. Nevertheless, our climate is so changeable that the method can be crucially tested on most days within five minutes by any one. I have used it during many years and on hundreds of occasions, and have found it at least as reliable as the, necessarily, belated weather reports given in newspapers. It is so simple that, as it seems to me, every one must know it; but, apparently, that is not so. In any case, I write only for the man who, perhaps knowing nothing about scientific meteorology, desires to ascertain for himself the kind of weather he is likely to experience during the next few hours.

Though clouds often condense during heavy downpours, they are popularly said to "dissolve in rain." Actually they disappear through evaporation. They "dry up," vanishing like steam out of a kettle, or like ground mist on the morning of a fine summer day. They climb from the horizon, but wax or wane on the way, condensing or thinning. If then the behaviour of the smallest and thinnest fragment of cloud that can be clearly isolated be watched, it is usually possible to predict very quickly and with fair confidence the state of the weather for the next few hours. If the cloudlet waxes visibly, rain is almost certain, if it wanes, fine weather is equally probable; if it neither waxes nor wanes, existing conditions are likely to continue. It is often much easier to be sure of the waning than of the waxing; for the total dis-

appearance of the cloudlet eliminates the possibility of observational error.

This method is inapplicable only when the sky is cloudless, or when it is of a uniform grey. It is uncertain when a high wind prevails; for then continents of cloud, dissolving perhaps but still dropping rain, may drift up from below the horizon. Of course the nearer the cloudlet (the lower it is) the more closely do the conditions in which it floats approximate to those on the ground, and the more easily may it be observed, and, therefore, the more confident may be the prediction. I have often watched a cloudlet diminishing under a grey and dripping blanket of cloud, and made plans for fine weather. It is said that a lenticular cloud may, at the same time, wax at one end and wane at the other. This implies that unlike weather conditions prevail at the two ends—possibly the meeting of a warm with a cold current, or a heating by the sun of one end, but not the other. Personally, I have observed it only when a cold mountain peak causes to windward the formation of a cloud which drifts along its sides, and dissolves to leeward—a pretty phenomenon which, as in some human affairs, gives an appearance of bustle without real progression.

Linked with this matter is the truth that red in the morning usually presages rain, and red in the evening fine weather. It is common knowledge that our prevailing wind is from the west, that only a low sun paints the clouds, that, speaking generally, it paints only those which are somewhat between it and the observer; and only those on which it shines directly. Thus a cloud that lies in the shadow of another which is nearer the sun is not coloured. Given a westerly wind, then, it follows that red in the morning implies that the sun is shining from a wide clear area in the east on clouds that have drifted overhead from the west. That is, it probably means that clouds are gathering. A glance to the west should settle the matter. On the other hand, when the western clouds are painted, that implies that the sun is shining, and the wind blowing, from a clear area beyond, and, therefore, that the clouds are breaking. It follows again that, if the wind be in the east, red in the morning should indicate bright weather and red in the evening rain.

But no matter what the cloud colours, the surest quick weather test is that furnished by the behaviour of a cloudlet, which, very often, may be seen to wax or wane with surprising swiftness.

G. ARCHDALL REID.

20 Lennox Road South,
Southsea, Hants,
October 27.

Alleged Rhætic Crane Flies.

IN NATURE of March 7 last, p. 351, reference is made to the discovery of two species of Rhætic crane flies, described by Dr. G. R. Wieland, palæobotanist, in the January number of the *American Journal of Science*. Copies of Dr. Wieland's paper have only recently reached me, and I was astonished to find, from the very clear photographs and diagrams published therein, that these wings are not dipterous at all. Apart from beetle elytra, the most abundant wings found in the Upper Triassic beds of Ipswich, Queensland (age, Rhætic or a little older), are Homopterous tegmina, most of which belong to the extinct family Scytinopteridæ, ancestral to the Cercopidæ. These tough tegmina have the peculiarity of usually splitting, when fossilised, along the *vena dividens*,

which is a deeply impressed concave vein (Cu_2) separating the anal area or clavus from the rest of the wing (Fig. 1). When the wedge-shaped clavus has become separated, the remainder of the wing appears to be very narrow at the base, and this would suggest a resemblance to dipterous wings, though the thick and strongly arched costa is quite unlike that of any Diptera.

Another point of resemblance between the two, which evidently deceived the author, is the frequent presence of a closed median cell (discal or discoidal cell, mc); but such a cell is found in many orders. All primitive Diptera have the radial sector with four or three branches, and all Diptera, without exception, like their allies the Mecoptera, have the first cubitus unbranched. The Rhætic wings have a simple radial sector and a forked first cubitus, and in these and all other characters agree with the Upper Triassic Scytinopteridæ.

The problem of the ancestry of the Diptera is one of the greatest interest, and it is important that no inaccurate determinations of fossil wings should confuse our view of it. The oldest known fossil Diptera at present are those from the Upper Lias of Europe.

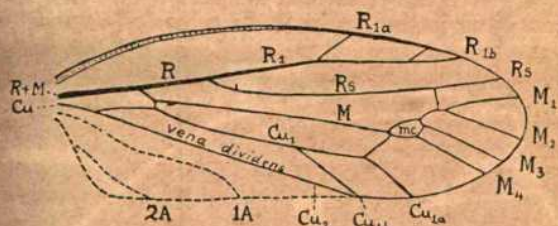


FIG. 1.—*Tipuloidea rhatica* (Tillyard) Wieland. Wing, with missing clavus restored by broken lines.

No Diptera are yet known from the Lower Lias. In the Upper Triassic beds of Ipswich, Queensland, the age of which is either Rhætic or a little older, the Diptera are replaced by their ancestral order Paratrachoptera, which had four wings and a venational scheme very much like that of the caddis-flies or Trichoptera, but with a simple instead of a forked first cubitus. I do not assert that true Diptera might not have existed in the Rhætic, but it is certainly highly improbable. The fossil record shows that the rest of the world in the Upper Permian.

Root-cap Development in *Calluna vulgaris*.

ONE of the characteristic differences between root-apex and stem-apex in a plant is that the meristem of the former produces a tissue in front of the apex known as the root-cap. In my experience this root-cap remains small even in roots

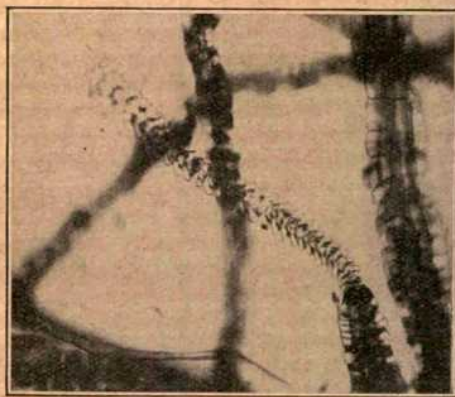


FIG. 1.—Root-cap development in *Calluna vulgaris*.

growing in water, owing to the disintegration of cells on the outside.

It is thought that the accompanying photograph (Fig. 1) of a root of *Calluna vulgaris*, grown for some months under controlled conditions as described in a recent paper (Rayner, *Brit. Journ. Exper. Biol.* vol. 2, 1925, p. 265) and showing the development of a root-cap of considerable length, may be of interest to botanists owing to its unusual character.

W. NEILSON JONES.

Botany Department,
Bedford College, London, N.W.1.

Rabbits in Africa.

THE common rabbit, I understand, is not indigenous to that part of Africa forming the Ethiopian zoological region, although it occurs in the Palæarctic part of the continent bordering on the Mediterranean. It is interesting, therefore, to note the occurrence of a well-established colony at Masindi, which has been there for so long that its origin is unknown to the natives, who give the rabbits the same name as the indigenous hare. For a long while I thought they

The London Skull.

By Prof. G. ELLIOT SMITH, F.R.S.

THE merit belongs to Mr. Warren R. Dawson of having recognised the importance of the fossilised fragment of a human cranium found during the excavation for Lloyd's new building in the City of London. I have to thank him for the opportunity of studying so interesting a specimen. Both of us wish to express our appreciation of the ready manner in which the members of the Committee of Lloyd's have placed the specimen at our disposal for scientific examination, and of their generosity in presenting it to the Anatomical Museum of University College, London.

Mr. Dawson has written the following account of the circumstances in which the fossil was discovered :

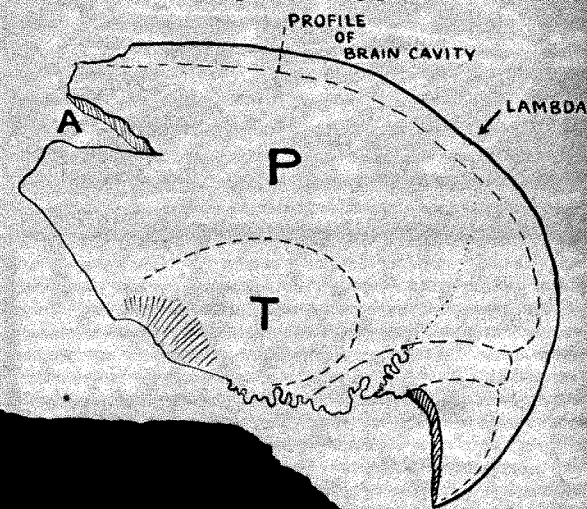
"During 1924 and 1925 the site bounded by Leadenhall Street, Lime Street, and Leadenhall Place in the City of London, upon which the historic East India House originally stood, has been excavated for the erection of a new building for the Corporation of Lloyd's. Before the erection of the steel-work began, the central part of the site was cleared by means of mechanical excavators; but as the stanchions and girders rendered the available space more and more restricted, part of the digging had to be done by manual labour. The chance of finding fossil bones was slight in that part of the area in which the steam excavator was used; for this apparatus raises large masses of earth at each plunge and deposits its burden bodily into iron skips, which are in turn hoisted by cranes and emptied into lorries. On such parts of the site as were dug out by manual labour, however, fossil bones have from time to time come to light.

"By the kind permission of the Committee of Lloyd's, facilities have been given for a scientific examination of these bones, and the clerk of the works, Mr. G. T. Murton, has in all cases carefully noted the exact depths and the nature of the soil in which the finds were made. In March 1925 I exhibited the specimens at a meeting of the Zoological Society. These comprised the head of a femur and some teeth of the mammoth found in the river

portion of the site. The fragment of skull was broken into four pieces by a blow from the excavator's pick; but one of the pieces (a small triangular splinter from A in Fig. 1) was not recovered. The other three pieces were fitted together and exhibited at a meeting of the Zoological Society of London on October 20. On that occasion the erroneous statement was made that the skull was found at a depth of 26 feet from the surface; but a few days later the clerk of the works directed my attention to the error and informed me that the human fossil came from the blue clay in the 42 feet level.

"The misunderstanding arose from the fact that our inquiries concerning the 'skull' were believed to refer to the remains of the ox found at a depth of 26 feet, and not to the flattened plates of bone, which were not recognised as parts of a skull."

This correction eliminates the difficulty that presented itself in attempting to associate a mineralised human skull revealing interesting primitive traits with



The London skull.

area T represents the situation (on the endocranial cast) of the temporal boss, and P the singularly ill-developed parietal area.

The bones are completely mineralised and of a reddish-brown colour. The condition of the cranial

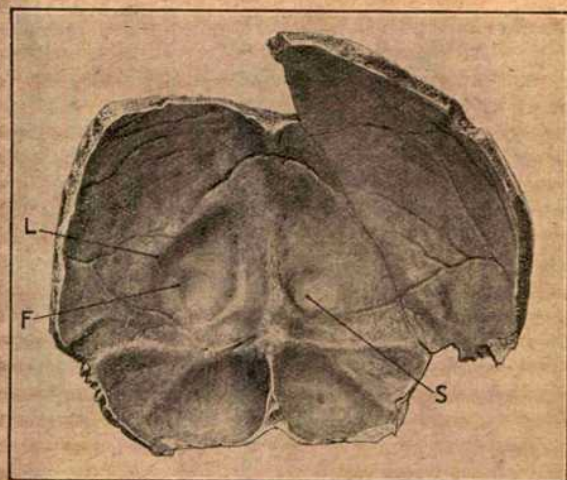


FIG. 2.—The inner surface of the cranium viewed from the front.

Drawn by A. K. Maxwell.

L, crista lunata on right side (left side of figure).
F, fossa areæ striatæ (with a ridge concentric with the crista lunata).
S, diminutive fossa areæ striatæ on left side.

sutures (lambdoid and sagittal) suggests an age of more than forty, but probably less than fifty years. The smoothness of the contour of the skull, and especially the faintness of the muscular impressions (Fig. 4), make it highly probable that the sex is female. The distinctness of the large lunate crest (Fig. 2, L), and the deep fossa striatæ (F) on the right side of the occipital bone—a reversal of the normal asymmetry—affords, as I pointed out in 1908 (*Brit. Med. Journ.*, Aug. 29, 1908, p. 597), clear proof of left-handedness.

The special interest of the relic arises from the fact that a skull which, from the circumstances of its deposition, is probably more recent than the known occurrence of the Neanderthal species, should reveal features so closely simulating those of the female crania of the Neanderthal type (those of Gibraltar and La Quina), and differ so profoundly from those of her (presumed) contemporaries of the Upper Palæolithic period. The height of the cranium is no greater than that of the La Quina woman (and the restored Gibraltar woman's skull); and the maximum breadth of the cranium is intermediate between the measurements in these two members of the Neanderthal species. The greatest breadth of the endocranial cast of the London skull

is 136 mm., that of the La Quina cast being 130 mm., and of the Gibraltar cast 140 mm.

The resemblances in the brain cases are indicated, however, not merely by the measurements of height and breadth, but also by the form of the endocranial casts, both their profile (Fig. 3) and the modelling of their surfaces (Fig. 5). The astonishing similarity of the size and shape in the profiles of the casts of the brain cases in the London, La Quina, and the Gibraltar skulls is brought out in Fig. 3. When one recalls that the London cast reveals a form suggestive of the short brain of the Gibraltar type rather than the long brain of the La Quina type (Fig. 3), and that the Gibraltar brain was wider than the Londoner's, it seems probable that the volume of the latter cannot have been much, if any, more than 1200 c.c.

In his memoir on the Neanderthal race (*Roy. Soc. Phil. Trans.*, 1907) Prof. Sollas describes the skull of an aboriginal Australian that was no higher than the Gibraltar skull. On comparing a replica of the endocranial cast of this skull (S.A. in Fig. 3), which Prof. Sollas gave me some years ago, it is found to agree even more nearly in profile with the La Quina cast, the only significant difference being a greater fulness in the parietal area. The Australian skull is usually as lofty as that of the modern British woman, the outline of whose endocranial cast is represented in Fig. 3.

This serves by contrast to emphasise the remarkable similarity of the London skull with those of the Neanderthal group and the exceptional Australian (S.A.). The cerebellum alone reveals any marked contrast. The fulness of this part of the brain in the London skull differs from the flattened form (cerebell.) of the Neanderthal and closely conforms to the type found in *Homo*

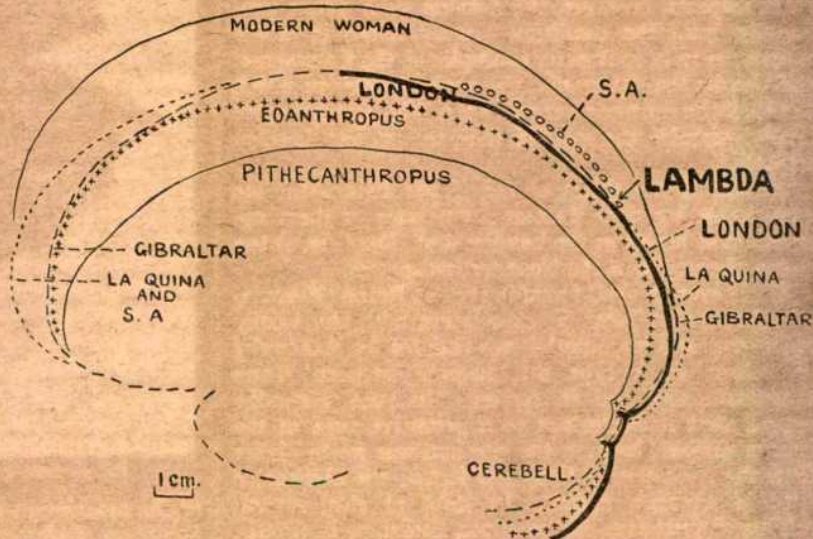


FIG. 3.—The outline of the endocranial cast of the London skull seen in profile from the left (thick line), compared with the Gibraltar and La Quina women and Prof. Sollas's Australian (S.A.), described in the *Roy. Soc. Phil. Trans.*, 1907, p. 325, as well as those of Pithecanthropus, Eoanthropus, and a random sample of a modern woman.

sapiens, as well as, curiously enough, in the Piltdown cast (Eoanthropus).

The modelling of the surface of the cerebral hemisphere in the endocranial cast (Fig. 5) reveals features of special interest. The localised swelling in the posterior

part of the temporal area (the temporal boss marked T in Fig. 5) is clearly defined, as it is in casts obtained from the La Quina, Piltdown, and Java (*Pithecanthropus*) crania, in all of which its distinctness is due partly to the lack of fulness in the parietal area (P). Even in the flat endocranial cast of Prof. Sollas's Australian skull the parietal area is prominent and no localised temporal boss is apparent. Though the parietal area is

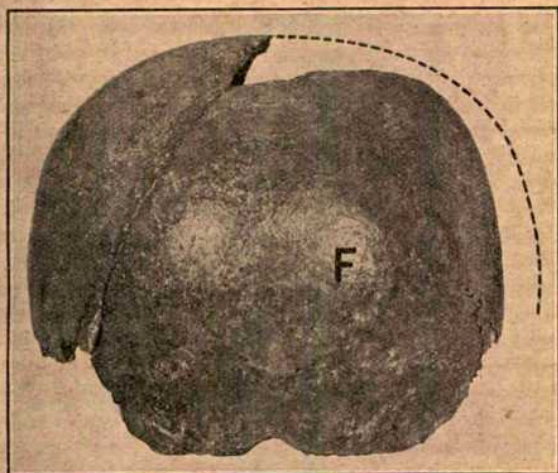


FIG. 4.—Back view of the London skull. The prominent boss on the right side at F is associated with the deep fossa striatæ (Fig. 2).

fuller in the London cast than in that of the La Quina skull, it resembles the latter more nearly than it does the Australian. The contour of the latter in Fig. 3 (S.A.) is merely one of the expressions of this increased parietal development. In this, and in fact in most other respects, however, the London skull differs profoundly from the condition usually found in *Homo sapiens*, even in such early examples as the Cromagnon and Combe Capelle crania, the brain cavities of which would, if the contours were shown in Fig. 3, much more nearly resemble the modern than the ancient London woman.

Several of the skulls of the Upper Palæolithic are remarkable for their flatness; but none of them approaches so nearly as the London skull does (Fig. 4) the shape distinctive of the Neanderthal species.

The Solutrean skull found in 1891 at Brünn (Moravia)—embedded in loess in association with the woolly rhinoceros and mammoth—was claimed by Makowsky to belong to a type intermediate between *Homo neanderthalensis* and *H. sapiens*. In 1906, Schwalbe argued that it conformed to a primitive type of the species *sapiens*, because the cranium was much higher than the Neanderthal form and lacked the distinctive type of eyebrow ridges. In spite of this, several anthropologists (see, for example, Stolyhwo in *Globus*, December 17, 1908, p. 363) refused to accept Schwalbe's view. The London skull affords much more definite evidence in support of these claims for the existence of an intermediate species than any of the Moravian specimens or Stolyhwo's Novosiolka skull reveals. In fact, the London endocranial cast (Fig. 5) reproduces the form of the Neanderthal type so nearly that the question of the possibility of the survival into Aurignacian times (in Britain) of a stray representative

of the species *neanderthalensis* is forced upon our consideration.

In spite of these considerations, however, one is not justified in claiming, on the evidence of data derived solely from the posterior part of the skull, that the London skull belongs to the Neanderthal species or to an intermediate type. The front end of the cranium or the face would have provided decisive evidence for the determination of the species; but unfortunately these parts of the skull are missing. Hence, as the fossil was found in a deposit definitely later than that in which Neanderthal man is known, and taking into consideration the range of variation in modern man, as displayed in the Australian skull (S.A. in Fig. 3), it would not be justifiable to claim this fragment of a skull as conclusive evidence of the survival of a member of the Neanderthal species into Upper Palæolithic times.

The thinness of the cranium is not a certain criterion of identity with the species *sapiens*, for the London skull is quite as thick as that of the La Quina woman.

In support of these tentative suggestions, the size and fulness of the cerebellum must be given some weight as an indication of affinity or identity with the species *sapiens*. The filling out of the parietal area, slight though it be, may possibly be indicative of a rank above that attained by the Neanderthal brain.

As to the date of the London skull, perhaps the most relevant facts are provided by the excavations in 1892 for the New Admiralty Buildings in London (Lewis Abbott, *Proc. Geol. Assoc.*, 1892, vol. 12, p. 346). The lowest terrace of the Thames provided evidence

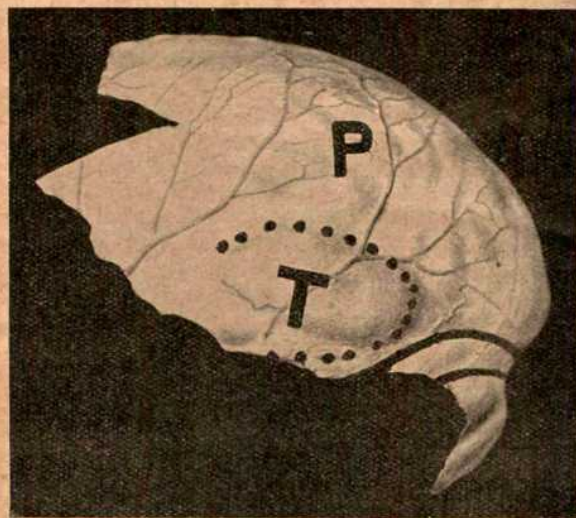


FIG. 5.—Left side of endocranial cast of the London skull.

of the association of the Pleistocene mammals with a Solutrean implement.

Whatever the fuller study of this remarkable skull may reveal, the fossil is certainly by far the oldest human relic yet found in the City of London and presents probably the nearest resemblance to the Neanderthal type ever found in a member of the species *sapiens*.

In the task of investigating this fossil I have had the benefit of the valuable advice of Profs. D. M. S. Watson and J. H. McGregor (of Columbia University).

Science in Russia.

By W. BATESON, F.R.S.

IN consultation with Sir Henry Miers and Prof. D'Arcy Thompson, who were among the British delegates, I have prepared the following account of our recent visit to Russia to the celebrations of the two-hundredth anniversary of the Russian Academy of Science. The celebrations began on September 5. We were to have six days in Leningrad, full of every kind of function both solemn and festive, to be followed by four more, similarly crowded with events, in Moscow. We came determined to see and hear all that we possibly could in the time; and aware that the gathering had been organised largely with an eye to its propaganda-value, I suppose that most of us with our curiosity combined a considerable measure of scepticism as to the real value of anything we might be shown.

Nothing could exceed the courtesy and hospitality with which we were received. Railway travelling in Russia was to be entirely free, and those who cared to do so were invited to visit any place in the country, Kieff, Odessa, etc., that could be seen before the end of September. At the frontier our baggage was passed in (and on the return journey passed out) unexamined, and we were authorised to send cables gratis. New motor omnibuses, specially sent from Moscow, met us at the station, and after we had been duly filmed, conveyed us to our hotel—a fine and well-appointed house. Rumour alleged that no other hotel could provide even reasonable comfort, but that may have been untrue. Of the ordinary charges we paid about half, but at Moscow, where we were distributed among several hotels, no charge at all was made.

If these preliminary symptoms inclined us to complacency we soon saw others of a different character. In the long drive through the streets of Leningrad the evidence of the empty and half-ruined buildings, the peeling walls, the dishevelled pavements, and the broken roadways—full of dangerous and neglected pits, above all the clothes of the population, with rarest exceptions, dingy and often improvised of coarse and unusual materials, were indications of troubles which no camouflage could conceal. Wherever we went in Leningrad, though in a slightly less degree perhaps in Moscow, we had the experience—to scientific persons novel and rather disconcerting—of finding ourselves conspicuously well dressed. It was indeed a little embarrassing to meet men of refinement and learning whose trousers were eked out with large and unrelated fragments, though almost worse to pass groups of artisans going home from work in rags which suggested the casual ward of a workhouse rather than decent employment. Readers of *NATURE* will not expect a report on social conditions, but some hint of the setting in which we saw what we did see can scarcely be omitted.

In preliminary announcements the numbers of foreign visitors expected had been given as about a hundred and fifty. We were not furnished with any list of those who did attend, but the highest estimate of our actual numbers which I heard was ninety-six. Of these perhaps half were representatives of mathematics and natural sciences in the stricter sense, the remainder being economists, historians, orientalists, and especially students of Slav languages, etc.

The proceedings opened with an evening reception in the rooms of the Academy. On this and on most other formal occasions our arrival was attended by a guard of honour with bayonets fixed, and we marched in under the lime-light of the ubiquitous cinema men. Here we found ourselves in an immense gathering assembled from all parts of Russia, representative of every kind of learning, and if several of the eminent foreigners whose presence had been promised failed to appear, there were no defects on the part of our hosts, for practically every one with whom we had acquaintance, direct or indirect, was there.

On the following Sunday we assembled for the first of several public seances, which both in Leningrad and Moscow constituted the formal business of the congress. Proceedings began—as always—with the singing of the International, which was followed by discourses of various kinds. After an introduction from the president, Karpinski, the secretary of the Academy, Oldenburg, gave an interesting history of its origin and activities, reminding us of the many distinguished men who had worked under its auspices. Other members of the Academy, especially Steklov and Lazarev, followed him, but alternating with them were speeches by members of the Government, giving their views on what science had done and might do for the people. At various times we were thus addressed by Kalinin, president of the Soviet, Krassin, Kameneff, Lunacharsky, minister of education—on several occasions—and other well-known leaders. At one of these seances Zinovieff, president of the Leningrad Soviet, gave a long and rhetorical address, developing an analogy between the aims of science and those of the revolutionists, which was afterwards printed.

Among much in all these speeches which of course escaped us, one conclusion very plainly emerged, that the revolutionary government is perfectly sincere in its determination to promote and foster science on a very large scale. Signs were not wanting that science, especially perhaps in its applications, is regarded by the present governors of Russia as the best of all propaganda. It was interesting to hear the faith that the advancement of science is a first duty of the State proclaimed by professional politicians. We ought perhaps not to inquire too closely whether they and we mean the same thing by the term science. Zinovieff, for example, speaks in the same breath of the "discovery" of Karl Marx and the "discovery" of Charles Darwin. Each of these men valued the work of the other, he told us, in a very high degree, and in evidence of Darwin's admiration of Marx he spoke of a letter, sent in acknowledgment of the book on capital, which was to be published. In an impassioned passage, which was enthusiastically applauded, he drew a parallel—derived from Lenin—between what science had done for the abolition of syphilis, patiently trying and discarding 605 reagents before 606 was reached, with what revolutionists were attempting for the abolition of capitalism. Capitalism was a scourge worse than syphilis, and if need be, not 606 but 6006 remedies must be tried so that the planet may be delivered once for all from its "yoke." Judging, however, from the

proportion of the population lost in the first experiments,¹ those who survive to benefit by the ultimate deliverance will be few.

Whether science will soon fulfil the many promises made in its name must be doubtful, yet not merely from what we heard, but also from what we saw, the failure we may be sure will not be for want of genuine effort. Next in importance after communism, the tenets of Leninism assert the doctrine that science is the basis of happiness. Religion is to be eradicated as a vice; science and the arts are to be promoted in its place. Those who regard this fervour for science as mere affectation for propaganda purposes miss an essential fact, and in our visits to laboratories and institutions, as related below, we found abundant and imposing evidence of the expression of this faith in material works. Of these new institutions we saw a great many, and though of course none of us could personally visit more than a part, we found on comparing notes that certain features were common to most of them. Palaces and great houses from which the owners have been dispossessed have been hastily adapted for the purposes of science. The effect was often incongruous. Though objects of value had been removed, we saw laboratory benches improvised among the remains of Empire furniture and statuary, and under Boucher ceilings representing nymphs sporting with amorini. Formerly each institution would have the Tsar's portrait and probably an occasional ikon. The modern analogue of these is the "red room," arranged as a sort of shrine of communism with the bust of Lenin, surrounded with copious literature of propaganda. Signs also there were that, in other and less innocent ways, not only the universities but also the various scientific institutions were utilised as agencies for the dissemination of communistic ideas.

Doubts might be entertained as to whether the best atmosphere for research has been created in the institutions, but no praise is too high for the zeal and vigour with which work is being conducted in the new circumstances. As typical of them may be mentioned the Institute of Zoological and Botanical Research under Prof. Philpitschenko and Prof. Dogiel, which has been set up in the house and parks of the Leuchtenberg family at Peterhof. Besides the permanent staff, many hundreds of students are there accommodated in the summer months, partly for instruction and in part co-operating in the experiments we saw in progress. The whole gave the impression of a very active and well-organised school, which has already done excellent work both in fundamental and applied biology. At Moscow Prof. Nawaschin and a band of cytologists trained by him are housed in a fine building and equipped with good instruments. His researches are of course classical, and we saw with satisfaction that in this case at least, one of the "purest" of biological sciences was not suffering through the competition of the applied branches.

Another very large house, also in Moscow, has been assigned to Prof. Koltsov as an Institute of Experi-

mental Biology. This includes numerous departments, especially a genetical station under Prof. Serebrovsky, work in experimental morphology, hydrobiology, etc. At the old Agricultural School at Petrovsky-Razumovsky, we saw more genetical work in application to agriculture and the long-established researches of Prof. Prianschnikov on agricultural chemistry. The Darwin Museum, created by Prof. Coats and his wife in illustration of the theory of evolution, was a remarkable and I believe unique curiosity. It contains a quantity of valuable and largely unpublished material bearing on the incidence of variation and a great number of other novelties. We were invited to inspect many more institutions, especially various establishments connected with public health, but all these I had to forgo.

Among the new organisations of a biological character the most extensive is the Institute of Applied Botany and Plant Breeding. The immediate object is to provide breeds of cereals and other agricultural plants for the various parts of Russia. The work is in the hands of Prof. Vavilov, who has already built up a great establishment for this purpose, employing 350 people, of whom some 200 are trained workers. In his travels through Turkestan, Afghanistan, and neighbouring countries, and by a vast correspondence, collections of seeds of wheat, barley, rye, millet, flax, etc., have been brought together on a great scale. The central office is in Leningrad and occupies a very large building, which is in great measure a living museum of economic plants as represented by their seeds. Of wheat alone some 13,000 forms are here collected. In various parts of the country are twelve subordinate stations, and by sowings made once in about three years it is proposed to perpetuate most of the collection alive. Besides a cytological department under Prof. Levitzky, there are special sections for meteorology, statistics, etc. Exceptional opportunities have been provided for investigating the geographical distribution of cultivated plants, especially in its bearing on problems of origin, which have resulted in several novel suggestions. At Dyetskoe (formerly Tsarskoe) Seló is the home breeding-station of this Institute. The chief building on it is a pleasant house, originally intended as a villa for Queen Victoria, and adjacent to this a number of laboratories and additional accommodation have been provided.

Sir Henry Miers contributes the following notes on three great Institutes, indicating the scale on which scientific work is contemplated in Russia, and its concentration in Moscow and Leningrad.

"*The Geological Commission*, recently installed in a vast new building in the Vassili Ostrov, contains numerous rooms for the geologists who take expeditions to all parts of the country and generally work up their material in the winter months. There are no less than 200 geologists and a total staff of 400. All results are classified and co-ordinated in a central bureau; the relative abundance and distribution of minerals of economic importance are collected in a graphic form on special maps. The whole top floor is being utilised as a museum.

"*The Aero-hydro-dynamical Institute* at Moscow, approaching completion, at an estimated cost of three million roubles. A new wind channel, 52 metres in length, built in two sections, 3 metres in diameter at

¹ Though accurate figures are wanting, some estimates may be formed from the "Report on Epidemics in Russia since 1914," 2 Parts, by Prof. L. Tarassévitch, published at Geneva, 1922, for the League of Nations. On the basis of the statistics provided he estimated that "Russia may consider herself fortunate if she emerges from the present crisis with the loss of 20-25 per cent. of her population." Pt. 2, p. 44.

one end, 6 metres at the other, is nearly finished. An experimental tank, like the Froude tank at the National Physical Laboratory, 225 metres long, 12 metres broad, and 6 metres in depth, is being constructed. A large experimental tower for wind experiments has been erected.

"The Institute of Applied Mineralogy in Moscow is being built on a grandiose scale at an estimated cost of 1,800,000 roubles, with an area from 9 to 12 thousand sq. metres and cubic content of about 60,000 cubic metres. It will be equipped for research work on a vast mass of material from all parts of the country.

"Typical of the organisation of research in special directions is the *Institute of Biological Physics*, in Moscow, directed by Prof. P. Lazarev; the whole interior of a large building has been rearranged for work on many branches of applied physics, and includes investigations on such subjects as the ionic theory of nervous excitation, with a geophysical laboratory in which researches on the remarkable magnetic anomaly of Kursk have been conducted.

"As an example of the growth and reorganisation of scientific collections:

"The *Mineralogical Museum* of the Academy has been quadrupled in extent during the last twenty years and has just been established as a national public mineralogical museum, distinct from that of geology, and fully equipped with laboratories.

"A visit to any school would show how important and overwhelming a part is played by nature study and elementary science in the education of children, especially in reference to all the affairs of life under the Soviet system."

Of the old-established scientific institutions, the Museums of Zoology and of Palæontology and the Botanic Garden were the only ones which I managed to visit. The fine and largely unique contents of the two museums are of course familiarly known. One recent acquisition I saw with mixed feelings—the almost complete skeleton of the giant *Indricotherium*, a rhinoceros-like creature, standing about twelve feet high at the shoulder. These bones, the collection of which has taken three years, were found exposed at Chalkar Tengiz, a remote and little known locality, but from the photograph of the site I saw that in 1886 I must have passed within a few yards of the very spot. The Botanic Garden alone still showed signs of the hardships through which it had come.

Great provisions are being also made for the development of art, archæology, and ethnology. Though unable to visit the *Musée Russe*, in which the collections illustrative of the history of the races included in the Soviet are preserved, I heard continually of its extraordinary excellence. Though it is the work of several decades, its recent extension has been much assisted under the new regime. Of the new developments at the Hermitage, Sir Martin Conway lately published an account. Among later novelties I was shown the astonishing collections brought from East Turkestan by M. Kozlov's recent expeditions. From tombs originally constructed at a depth of twelve metres below the surface and permanently immersed in water, have been brought a vast series of textiles, both woollen quilts and silks in admirable preservation,

together with ornaments of various kinds and domestic objects, the whole belonging to a civilisation previously unknown. The decorations representing stylised animals, especially reindeer (possibly elk) and oxen, are evidently Sassanian in affinity, as M. Orbeli demonstrated. Some of the designs in the silk fabrics are of incomparable beauty, and very striking also are fragments of a curious red and black lacquer showing the utmost delicacy of taste and workmanship. These remains have not as yet been dated with certainty, but are presumed to cover a long period belonging chiefly to the sixth-seventh century A.D., but in part probably to a much earlier epoch.

Of all the things seen I suppose the interior of the *Usspensky Sobor*, the great Cathedral of the Coronations, exhibited the greatest break with past traditions. Until lately the whole was plastered with gold leaf and paintings rising little above the *objêt de pitié* type of art, giving an effect certainly solemn and gorgeous but tasteless and oppressive. The archæologists have declared the whole of this display of orthodoxy to be modern and debased. The process of stripping has been begun and is steadily proceeding under scholarly and skilful guidance. The ancient pictures are being slowly recovered and will be seen before long as they were intended to be seen upon the original white of the walls. The most famous and venerable of all ikons, the *Korsun Madonna*, traditionally ascribed to St. Luke, has already been cleared. I remember it looking like a piece of black leather. Seven layers of paint have been removed and a most remarkable original picture has been displayed in its entirety. Terrible judgments were expected by the common people to follow these impieties and the opening of the reliquaries by which they were accompanied. Time alone can show whether their anticipations will be justified, but meanwhile there is no gainsaying the fact that in the restorations which are to be extended throughout the Kremlin churches, and carried out upon every ikon of importance, the history of religious art in Russia will be revealed.

Of the banquets, lordly, if indeed the term princely were not more appropriate, graced, as that in Moscow at least was, with Imperial porcelain and madeira; of the operas, of the ballets and the sumptuous production at the Arts Theatre, where several of the courtly costumes were real brocades—lately somebody's "properties" in the fullest sense—one I verily believe lent from the Kremlin collection itself—this is not the place to speak at length.

We left with no clear conception of the principles or practice of communism; and in particular as we looked round at the 1200 persons assembled for the Moscow banquet, in a city teeming with beggars, we tried in vain to conjecture any system by which admission to the table, or exclusion from it, may have been determined. Of liberty we saw no sign. We here are accustomed to think of science and learning as flourishing best in quiet places, where they may come to slow perfection, under systems providing a reasonable measure of personal independence and security. Present conditions in Russia have brought about the very contrary, and among the grave indications of disharmony, which every visitor observes, the want of freedom is by far the most serious.

Obituary.

MR. J. S. GAMBLE, C.I.E., F.R.S.

A FEW weeks ago the Indian Forest Service and British forestry had to deplore the loss of Sir William Schlich, who may be said to have been the doyen of British Empire forestry. Following shortly on the death of his friend, the Indian Service has now lost another great forester in the person of James Sykes Gamble, who, on his departure from India in 1899, left a great reputation behind him both as a scientific forester of the first calibre, an educationist, and a great botanist. Gamble went out to India when the botany of the forest was imperfectly known for the practical forester's purpose and the Indian timbers were quite unknown. Before he left the country he placed in the hands of the Indian forester a manual the value of which received immediate recognition.

Gamble was the second son of Dr Harpur Gamble, R.N., and was born in London on July 2, 1847. He was educated at the Royal Navy School, New Cross, and at Magdalen College, Oxford, where he took firsts in Mathematical Moderations and in the Final School of Mathematics. The following year, 1869, he was selected by the Secretary of State for India to undergo training on the Continent for the Indian Forest Service. This scheme had been recently inaugurated by Sir Dietrich Brandis, at that time the first Inspector-General of Forests in India. Out of the seven selected in that year, Gamble and three others were deputed to the Nancy Forest School, the rest going to Germany. Gamble had many stories of the interesting life he led at Nancy, where he was trained under some of the greatest foresters of the day. He was under M. Clément de Grandprey in the fine forest of Haguenau before he went to the School. At the latter place at the time there were some of the best known names in French forestry, Nanquette being director. In the jubilee number of the *Indian Forester* (July 1925) Gamble wrote: "Personally, I can testify to having started my interest in wood-structure under the auspices of Professor Mathieu and with the help of the well-arranged collection in the wood-chalet in the School Garden." The Franco-Prussian War interfered with the English students' studies at Nancy and they were transferred to Scotland under Dr. Cleghorn, who had made a great name in Indian forestry annals and had been associated with Brandis in the first organisation of the Forest Service (1863-64). In the spring of 1871 Gamble returned to Nancy, and in November he sailed for Calcutta, taking out with him some Wardian cases of *Ipecacuanha* for the Botanic Gardens. It was this commission, received from the India Office, which took Gamble to Kew, where, under the guidance of Sir Joseph Hooker, he paid his first visit to the Gardens and Herbarium, thus starting an association with the Gardens which was to continue in later years and to last until his death. With these cases in his charge he landed at the privateghat (landing stage) of the Calcutta Gardens on the Hoogly River, and it was from the same ghat that he took his departure from India twenty-eight years later.

Gamble was posted to Burma and, like every man who goes first to that fascinating country, fell in love with it and with the forests. His stay in Burma was

short, for in August 1872 he received orders to report in Bengal, orders he was very reluctant to comply with. In those days forest organisation in Bengal did not exist. Towards the end of the year Schlich was sent to Bengal as Conservator, and the friendship which was to last through life commenced between these two men. Before Schlich left Bengal he had placed forest administration on a firm basis, and Gamble afterwards carried on the work, as also the editorship of the *Indian Forester*, which Schlich founded in 1875. For a time Gamble was Conservator in Madras, and in 1890 he was transferred to the North-West Provinces (now United Provinces) as Director of the Imperial Forest School at Dehra Dun and Conservator of the School Circle, comprising an area of forests in the lovely Dun and Siwaliks and neighbouring Jaunsar Himalaya. Gamble proved himself one of the best directors the School has ever had. In connexion with the School he planted a small arboretum, which the writer had the good fortune to visit for the first time in his company, and saw once again in April last during a visit to India.

The Indian forest officer owes a great debt to Gamble on the score of the valuable botanical work he accomplished; but it should be recorded that the latter was a thoroughly efficient forest officer and in his day carried out some remarkably fine work. He was an indefatigable research worker and a patient cataloguer. In his early days in Bengal he prepared a list of the trees, shrubs, and climbers of the Darjiling district, a second edition of which was published in 1895. As an outcome of his work in Madras he compiled a flora of that Presidency. He drew up a list of the *Bambuseæ* of British India, published in the *Annals of the Royal Botanic Garden, Calcutta*.

It was while he was associated with Brandis as Assistant Inspector-General of Forests that he commenced the research work on Indian timbers, which resulted in the publication of his great work "A Manual of Indian Timbers," for which generations of Indian forest officers have blessed the name of Gamble. This first appeared in 1881, was soon out of print, and for a decade the young Indian forest recruit was almost helpless in the forest in the absence of such an essential handbook. A second edition, much amplified, appeared in 1902, and a third three years ago, the latter an improvement even on the second.

In the year of his retirement Gamble was made a C.I.E., and in the same year was elected a fellow of the Royal Society. In 1900 he was put in charge of the organisation of the forestry exhibit at the Paris Exposition of that year. The whole of the objects were assembled and arranged and tabulated in Calcutta by Mr. F. Manson, to whom the writer acted as assistant on what proved an extremely interesting piece of work. Gamble was awarded the Jury Medal and Diploma of the Exposition for this work; he also received the Barclay Medal of the Royal Asiatic Society of Bengal. He was elected to the Athenæum in 1902.

Gamble collaborated with the late Sir George King in materials for a flora of the Malay Peninsula, work which he afterwards carried on by himself. He was also associated with Schlich at Oxford in the training of Indian forest probationers and lectured on Indian

forest botany. He settled at Highfield, Liss, in Hampshire, and married, in 1911, Gertrude, daughter of the Rev. A. S. Latter.

To the Indian Forest Department and his many old friends Gamble's death will come as a great blow. He has left behind him an enduring memorial by which many a young forest officer who never met him will revere his name. E. P. STEBBING.

PROF. W. WRIGHT SMITH has sent us the following brief notes on Mr. J. S. Gamble's botanical work:

Gamble was associated with the late Sir George King on a very extensive publication entitled "Materials for a Flora of the Malayan Peninsula." This was started by Sir George King, who was responsible for Nos. 1-13; then King and Gamble appear as the authors for Nos. 14-21. These papers appeared in the Journal of the Asiatic Society of Bengal for the years 1903-1909, and the last numbers contain chiefly the Gamopetalæ. On the death of King, Gamble completed the work to the end of the dicotyledons. This constituted Nos. 22-25—published 1912-1915—and represented the orders Nyctagineæ up to Salicaceæ. One or two of the families were done by other authors.

On the completion of this very large work—I should perhaps have noted that Ridley had already done the monocotyledons of the area—Gamble turned his attention to the flora of Madras, and during the years 1915-1924 he published six parts of the "Flora of the Presidency of Madras," from Ranunculaceæ down to Plantagineæ. At the time of his death he was busily engaged on the Urticaceæ and had hopes of bringing out another part at an early date.

The very many new species which came to light during the work on the flora of the Malayan Peninsula, and also on the flora of Madras, appeared in numerous short papers scattered throughout the *Kew Bulletin* during the last twenty years.

PROF. E. H. BARTON, F.R.S.

THE scientific world has lost a very able and steadfast worker in the person of Prof. Edwin Henry Barton, professor of physics in University College, Nottingham, who died suddenly on Wednesday, September 23, when starting, in apparently perfect health, for a day's walk. He leaves a widow and two sons.

Prof. Barton was born in Nottingham in 1859, and lived there all his life except for two years spent in study, the first under Sir Arthur Rucker in the Imperial College of Science, London; the second under Hertz at the University of Bonn. The recognition of his talent, or perhaps the opportunity to develop it, came to him comparatively late in life, for he was a trained engineering draftsman when, at the opening of the University College, Nottingham, he commenced a course of study, and at the age of thirty-one years passed the London matriculation. His career as a student was brilliant, and he was awarded an 1851 Exhibition Research Scholarship. On returning to Nottingham in 1893 after his training in London and Bonn, he became lecturer in physics, and in 1906 professor and head of his department. His published scientific work was recognised in 1916 by election into the Royal Society.

Prof. Barton was the author of some very useful books for students; the best known being his "Text-book on Sound." This book from its scope and careful treatment may be held to complete a trilogy with Preston's "Light" and "Heat," so well known to advanced students. Prof. Barton's other works were "Analytical Mechanics" and "Introduction to the Mechanics of Fluids." At the time of his death he was well on the way with an advanced treatise on "Properties of Matter." To Glazebrook's "Dictionary of Applied Physics" he contributed the article on "Sound." His published papers, about sixty, were mostly in the *Philosophical Magazine*. When with Hertz, he commenced research on electric vibrations, and his earlier papers dealt with the transmission, damping, and reflection of waves along wires. In later years he turned rather to acoustic and other mechanical vibrations. In the sound experiments he adopted optical levers attached to the various parts of the moving wire or plate to amplify the vibrations, which he then recorded photographically.

As most of Prof. Barton's papers were collaborations, a great number of students and colleagues had the benefit of his inspiration in these researches. In particular, in the last eight years he published a series of no less than fourteen papers with Dr. H. Mary Browning, who was first his student and later his colleague. In this series the author used coupled and triple pendulums to illustrate the close analogy existing between electrical, optical, and mechanical vibrations, in all cases bringing the mathematical theory into relation with the physical action.

We have good authority for saying that the best early training for a would-be physicist is either mathematics or engineering. Prof. Barton, as we have seen, began life as engineer, and in his student career showed great mathematical ability, so he may be said to have happily combined both the desiderata specified. By nature a student, he was conversant with most branches of his very progressive subject with its voluminous recent addition of the "new" physics, relativity and quantum. When lecturing he handled his subject with a thoroughness which carried conviction and with a wealth of illustration which sustained the attention of his audience.

Prof. Barton was well known as an expert in sound, and as such was consulted by musicians and experimentalists in sound in various parts of the world. As regards the practice of music he was a *virtuoso* and could perform on many instruments. This faculty served him for demonstration in lectures and for his researches; so that the physics wing at Nottingham often resounded to the merry strains of cornet, trumpet, harmonicon, or other kinds of music. He was a very popular head of his department at Nottingham, where his great ability and invariable courtesy will not soon be forgotten.

His special talent may be held to pass on to the next generation, as his two sons both had brilliant careers in physics at Cambridge.

DR. GEORG SCHWEINFURTH.

GEORG AUGUST SCHWEINFURTH, who was born at Riga, of German parents, on December 29, 1836, and died in Berlin on September 20 last, was a naturalist

who gained great distinction by his travels and discoveries in East Central Africa. A trained botanist, he was chosen at the age of twenty-seven to classify and arrange the Barim and Hartmann collections brought from the Sudan. In 1863-66 he studied on the spot the flora of Egypt and adjacent regions from the Delta to Khartum and from the Red Sea along the slopes of the Abyssinian highlands to the Blue Nile. In 1866, with funds provided by the Humboldt-Stiftung, he set out for the Bahr-el-Ghazel province of the Sudan.

Schweinfurth's journey, which lasted three years, was one of the most fruitful ever carried out by a traveller in Africa. Undertaken primarily for the purpose of botanical investigation, it took on a much wider scope. Schweinfurth studied not only the flora but also the fauna and the orography of the country. He did a great deal to elucidate its puzzling hydrography. Crossing the Nile watershed he discovered the Welle. This great river, one of the chief tributaries of the Congo, he believed at the time to belong to the Lake Chad basin. This detracted little from the value of his discovery, which won for him the award, in 1874, of the Founder's Medal of the Royal Geographical Society. Above all, however, Schweinfurth studied the people, and to him we owe almost the first accurate account of the Diur, Dinka, Bongo, and the cannibal Azandeh (or Niam-Niam) and Mangbettu. His discovery of the Akka pygmies settled conclusively the then vexed question as to the existence of dwarf races in Central Africa.

In regard to fauna, Schweinfurth's most notable discovery was that of an aberrant type of chimpanzee (*A. troglodytes schweinfurthi*) in the Azandeh country. The existence of the chimpanzee in the Nile basin was previously unknown; Schweinfurth also found the grey parrot and other West African types in the Nile regions. His botanical work was extensive; he revealed the eastward extension of the great equatorial forest and vividly described the remarkable "gallery" formations it contains; avenues of gigantic trees "like the colonnade of an Egyptian temple," and "aisles and corridors" in the innermost recesses of apparently impenetrable woods. (This formation, as Schweinfurth carefully acknowledged, had been previously reported by Carlo Piaggia.) The account of his journey, "The Heart of Africa," first published in 1873, abounds in passages in which the character of the scenery is clearly depicted, and the description is aided by reproductions of his own drawings—for to the gift of careful observation Schweinfurth added that of a capable artist. Taken in all, with its attractive style, its fullness of information concerning the people, the country, and its flora and fauna, and remembering that the period dealt with was one when slave-raiding and ivory hunting were the chief industries, "The Heart of Africa" is scarcely exceeded in interest by any other work on African travel.

Schweinfurth never returned to Central Africa, but made many other shorter expeditions. In 1873-74 he was in the Libyan Desert with Gerhard Rohlfs, and between 1876 and 1888 he visited south-west Arabia several times, adding considerably to the knowledge of that region. In the intervals he lived at Cairo, where, in 1875, he founded, under Ismail Pasha's auspices, the Société Khédiviale de Géographie. He also continued

his botanical and geological investigation of the lower Nile valley. In 1889 he took up his residence in Berlin, where, save for visits to Eritrea (1891-94), he remained. His interest in Africa never ceased, and a new edition of "The Heart of Africa," with much new material, appeared in 1918. His botanical and geological collections are now exhibited in the Berlin Museum.

MR. WILLIAM WELSH.

MR. WILLIAM WELSH, whose death occurred on September 12, was born at Edinburgh in 1859. After being educated at George Watson's College he went, at fifteen years of age, to the University of Edinburgh, where he worked under Tait and Blackie. From there he proceeded to Jesus College, Cambridge, where, under the guidance of Routh, he secured the senior position in the Mathematical Tripos of 1882 and in the Smith's Prize examination in the following year. Elected to a fellowship in 1883, he remained on the active staff of his college until his death.

By the death of Welsh, Cambridge has lost one of the best of her mathematical teachers. The ability he possessed for getting at the essence of a subject, and in reducing its analytical cloak to a minimum, always enabled him to present it in a form which for lucidity, elegance and thoroughness could scarcely be equalled. He treated his subjects as such, and not as a means to solving a large number of tricky problems—an art in which he himself specially excelled—and he was a strong advocate of that part of the reform incorporated in the new Tripos in 1910 which forced a more uniform adoption of the practice of subject-lecturing.

Welsh was a member of the small Cambridge board which drew up one of the first syllabuses of reformed geometrical teaching for schools. But, like so many of the prime movers in this matter, he afterwards regretted his part in the work, on account of the rapid decline of geometrical teaching which resulted from it. Not that he ever felt that the reform was not an improvement, but because events proved the impropriety of making it without a great deal of previous preparation.

Welsh was a man of an extraordinarily retiring nature, always anxious to avoid publicity in any form. He was, however, possessed of a singular charm of character, and he will be greatly missed in a small circle of intimate friends and in the larger sphere of mathematical teachers at Cambridge. The spirit of his genius will live for a long time in the generations of younger mathematicians who had the good fortune to come under his influence.

G. H. L.

WE regret to announce the following deaths:

Mr. Francis Jones, senior chemistry master of Manchester Grammar School from 1872 until 1919, and the author of numerous text-books on chemistry, on October 22, aged eighty years.

Prof. W. Kilian, professor of geology and mineralogy in the University of Grenoble and member of the Paris Academy of Sciences, aged sixty-three years.

Sir John Struthers, K.C.B., formerly Secretary of the Scottish Board of Education and a trustee and sometime vice-chairman of the Carnegie Trust, on October 25, aged sixty-eight years.

Current Topics and Events.

At the annual statutory meeting of the Royal Society of Edinburgh held on October 26, the president, Sir Alfred Ewing, delivered an address on some of the modern aspects of physical research. He said that the functions of a scientific society are to provide (1) facilities for intercourse, formal and informal; (2) a library of reference; and (3) a means of publication. The records of scientific research are not a readily marketable commodity and would fare badly if they were left to depend on the laws of supply and demand. Looking back through the old publications of the Royal Society of Edinburgh would disclose many papers by Kelvin and others which may without exaggeration be described as marking epochs in the history of discovery. The urge towards scientific research is not mainly utilitarian, but arises from a special type of intellectual curiosity. A scientific society is, consciously or not, propagandist in that it extends an interest in science beyond the bounds of the scientific workers. There is, in fact, a greatly changed attitude now towards science and the scientific method. Research has now found a place not only in manufacture and in industry, but even in the budgets of the politician. The foundations of the older physics have been rudely shaken, with a notable effect on the mental attitude of the scientific expert. The old positiveness is gone. We are faced with dilemmas from which there is apparently no way out. For example, how to reconcile the facts of interference and diffraction with the equally well-established facts of absorption and photo-electricity, we simply do not know. Hence, along with the pride of achievement in all this notable progress, there is mingled a consciousness of mystery and humility. The widening of the circle of light has made wider the circumference of darkness which, for the moment at least, seems curiously impenetrable.

THE Therapeutic Substances Act which was recently passed provides for the regulation of the manufacture, sale, and importation of vaccines, sera, and other therapeutic substances, and requires that these substances shall comply with standards to be prescribed for their strength, quality, and purity. In order to provide facilities for carrying out the necessary tests, the Pharmaceutical Society of Great Britain decided to establish and equip laboratories for that purpose, and has appointed Dr. J. H. Burn as the Director. Dr. Burn was educated at Barnard Castle School, and gained an open scholarship in natural science at Emanuel College, Cambridge, afterwards obtaining a first class in the Natural Science Tripos. With the exception of two and a half years' war service, Dr. Burn has devoted himself mainly to research work in physiology carried out under Prof. Joseph Barcroft, Sir F. G. Hopkins, and, at the National Institute of Medical Research, under Dr. H. H. Dale. In this Institute he directed his attention chiefly to the examination of the methods for testing biological products the activity of which cannot be determined by chemical assay. Dr. Burn has published, chiefly in the *Journal of Physiology*,

numerous papers on the testing of pituitary extract, neo-salvarsan, etc. It is intended that the new laboratories shall be used not only for routine testing by biological methods, but also for carrying out researches in pharmacology, and it may be confidently expected that, under Dr. Burn's expert guidance, they will play an important part in the scientific development of organotherapy, to which increasing attention is now being devoted.

In an address given on October 21 before the British Commercial Gas Association meeting at Plymouth, on the "Conservation of the Nation's Store of Solar Energy," Prof. J. W. Cobb dealt with the relative economy of alternative methods of utilising our coal supplies. Our requirements of artificial heat exceed what can be obtained directly from the sun or indirectly from the growth of "fuel crops" from year to year, or even from century to century. We depend on an accumulated store of fossilised fuel. In the use of coal we are actually drawing on a wasting store. The conversion of coal into electricity involves a loss of 80-90 per cent. in the power station itself, and this loss must be regarded as an extravagance where the distribution of heat for most purposes is concerned. The loss is much reduced when the coal is first carbonised and the gaseous and solid carbonisation products are used as fuel. The initial loss is then some 20 per cent. only, and this loss is compensated by the increased value and efficiency in use of the products. The carbonisation of coal at lower temperatures than customary now, is beset with difficulties both technical and commercial, the nature of which was indicated, but it seems probable that the gas and coke industries will adapt themselves to supply the smokeless fuel which public opinion is demanding ever more insistently.

THE first annual report to the Court of Governors and the report on the work of the Tropical Division for the year ended July 31, 1925, of the London School of Hygiene and Tropical Medicine, describe the progress made under the directorship of Dr. Andrew Balfour in the foundation of this new school. On August 1, 1924, the London School of Tropical Medicine became an integral part of the new school and its first working division. Mr. Morley Horder has been appointed architect, and it is expected that the foundation stone of the School will be laid on the site in Gower Street during the session 1925-1926. The Trustees of the Rockefeller Foundation have generously agreed that the promise of two million dollars made in February 1922 shall be interpreted as 460,830*l.*, the value in sterling of the sum promised at the time of the original undertaking. Of this, 52,610*l.* has been expended by the Ministry of Health on the purchase of the site. Concurrently with the preparation of plans for the new building, the Education Committee and the Director have drawn up a provisional scheme of studies. The Board has recognised the necessity for taking early steps to secure the services of the prospective heads of Divisions,

and to this end, and in order to supplement the teaching for the Diploma of Public Health, the University Grants Committee has made provision for a grant of 5000*l.* for the year ending July 31, 1926, supplemental to the grant of 2300*l.* made in the past to the London School of Tropical Medicine. This sum of 7200*l.* is available for the work as a whole, apart from the sum of 4000*l.* provided annually by the Rockefeller Trust for the general work of administration. The steps taken by the Board as a result of the Treasury grant of 5000*l.* will include application to the Senate of the University of London to set up Boards of Advisers for the appointment of professors, and in the meantime the securing of advice and assistance from competent authorities in regard to planning, equipment, and organisation. Arrangements will also be made for lectures in physiology as applied to hygiene, and in bio-chemistry, and for progress in the equipment and organisation of the Museum.

THE Director's report on the work of the Tropical Division of the London School of Tropical Hygiene and Medicine sets forth the activities of the various departments and the extent of the research work undertaken. Arrangements have been made with the Government of Southern Rhodesia for the prosecution of medical research in that colony. A Research Fellowship in Comparative Pathology has been established, and the holder has assumed the duties of pathologist to the Zoological Society. A Research Fellowship in Spirochaetosis has also been founded, while there are hopes that an Entomological Field Station will be set up at the Air Ministry's Camp at Halton, Bucks. In regard to the instructional courses given in this Division a notable change has been made. Owing to the increasing congestion of the courses of study it has been decided to conduct only two courses each year in place of the three previously held. It is anticipated that this change will increase the educational value of the teaching, and enable more attention to be paid to the subject of tropical hygiene.

In the *World's Health* for October an interesting account is given by Captain Reuterskiold of the aerial ambulance in Sweden. There are vast districts with comparatively large populations which are totally deprived of means of locomotion during part of the year. In winter the roads are obstructed by snow-drifts, and in summer many villages may be isolated by floods caused by the melting snows. In these circumstances it was decided to make a trial of aerial transport, and the Government in 1923 agreed to share the expense of purchase of an aeroplane with the Swedish Red Cross. A Bréguet biplane was chosen, with a 300 H.P. 12-cylinder water-cooled Renault engine, capable of carrying two stretcher cases with one attendant. Wheels were impracticable and were replaced by skis, and a pair of floats were added to facilitate landing on water. Military airmen piloted the machine, and the service began in December 1924. During the winter eleven patients were transported. One patient, suffering from hæmorrhage and living in a very isolated district,

was transported to Boden in an hour and a half, whereas the journey by sledge would have taken twenty hours, thus gaining eighteen and a half valuable hours.

THE first article in the Journal of the Franklin Institute for September, entitled "The Way of the Wind," is contributed by Dr. W. J. Humphreys, of the United States Weather Bureau. In it he discusses, mathematically and physically, the main factors that cause the wind to blow apparently "where it listeth," the mathematical treatment dealing with what must happen, if the initial assumptions made are both accurate and complete, and the physical considerations seeking to elucidate what actually does happen. Recent advances in the theory and practice of wireless propagation are ably summarised by Dr. A. S. Eve, and a technical paper on the action of hydrogen peroxide on photographic plates containing a single layer of silver halide is communicated by Dr. C. E. K. Mees, of the Eastman Kodak Company. Such plates are only very slightly attacked by hydrogen peroxide, and the investigation tends to uphold the view that the action of this reagent on ordinary plates is due to chemiluminescence. Irregularities in the variation of certain properties of zinc with the temperature are frequently ascribed to the existence of allotropic modifications of the metal, and this hypothesis has been studied in the research laboratory of the New Jersey Zinc Company by means of X-ray analysis and re-determination of the lattice structure of pure zinc. As no change was observed in the X-ray spectrograph at atmospheric pressure and between 20° and 400° C, it is concluded that no allotropic transformations occur within this range of temperature. As usual, the Journal also contains a number of excellent abstracts of publications issued by the Bureau of Standards and other government departments, and reviews of recent scientific publications.

DR. C. G. ABBOT, director of the Astrophysical Observatory, Washington, and secretary of the Smithsonian Institution, will deliver a popular lecture before the Royal Meteorological Society on November 11. The title of the lecture will be "Measuring the Sun's Rays."

THE Huxley Memorial Lecture of the Royal Anthropological Institute will be delivered on Tuesday, November 24, at 8.30, at the Royal Society, by Sir Arthur Evans, who will speak on "Early Nilotic, Libyan, and Egyptian Relations with Minoan Crete."

A CONFERENCE on recent developments in the manuring of potatoes will be held at the Rothamsted Experimental Station on Friday, November 20, at 11.30 A.M. The speakers will include: Sir John Russell, Mr. J. C. Wallace, Mr. R. W. Wheldon, and Mr. T. Eden. Those intending to be present are requested to communicate with the Secretary, Rothamsted Experimental Station, Harpenden.

WE are officially informed that in view of the large number of overseas exhibits which are to be trans-

ferred to the Imperial Institute from Wembley, and of the extensive reorganisation which this will involve, it has been decided to close the Institute Galleries entirely from November 1 for three months. The lectures to the public and to school parties, usually given in the galleries, will also be suspended for that period. While the temporary closing of these important galleries—the permanent exhibition of Empire resources—and the interruption of their educational work are to be regretted, we are sure that the decision will be amply justified in the greatly enhanced interest and attractiveness of the collections.

A NEARLY complete skeleton of a new species of the Iguanodont Dinosaur *Trachodon* has just been mounted in the museum of the Geological Committee at Leningrad. The specimen was found in an Upper Cretaceous conglomerate on the Amour river, a little below the mouth of the Ayan, and is now being studied by Dr. A. Riabinin, who has published a preliminary note on it, with a photograph, in the Committee's Proceedings. The backbone measures nearly 8 metres in length, and when walking the reptile would be about $4\frac{1}{2}$ metres high. The species seems to be closely related to the *Trachodon* (*Claosaurus*) *annectens* described by Marsh from a corresponding geological formation in Wyoming, U.S.A.

APPLICATIONS are invited from natural-born British subjects of either sex of not more than 30 years of age for the Harrison Memorial Prize, the value of which is about 150*l.* The prize if awarded will be to the candidate who, in the opinion of the selection committee, during the previous five years has conducted the most meritorious and promising original investigations in any branch of pure or applied chemistry and published the results of those investigations in a scientific periodical or periodicals. Applications should be made by, at latest, December 1 to the President, The Chemical Society, Burlington House, Piccadilly, W.1.

NOTICE is given by the Chemical Society that a meeting of the research fund committee will be held in December. Applications for grants must be made on or before Tuesday, December 1, on forms obtainable from the Assistant Secretary, Chemical Society, Burlington House, Piccadilly, W.1. The income arising from the donation of the Goldsmiths' Company is more or less especially devoted to the encouragement of research in inorganic and metallurgical chemistry, and the income from the Perkin Memorial Fund is applied to investigations relating to the problems connected with the coal-tar and allied industries.

THE following officers have been elected for two years by the Australian National Research Council: *President*, Sir David Orme Masson; *Vice-Presidents*, Sir Edgeworth David, Sir Baldwin Spencer, Sir George Knibbs, Mr. J. H. Maiden; *Hon. Secretary-Treasurer*, Mr. R. H. Cambage; *Joint Hon. Secretary*, Prof. A. C. D. Rivett. At the annual meeting held in Sydney in August it was decided to endeavour this year to obtain from private sources a sub-

stantial permanent endowment in order to place the Research Council on a firm and independent financial footing. It was resolved also to retain membership of all the International Unions. In the case of the Union of Pure and Applied Chemistry, the Australian Chemical Institute will co-operate with the Research Council in conducting all local activities of the Union.

THE Leeds Philosophical and Literary Society is one of the oldest institutions of its kind in Great Britain, having recently celebrated its centenary. The Society helped effectively to bring the University of Leeds into existence, and is now in close association with the University. It is appropriate, therefore, that opportunities should be provided for the communication and publication of original papers, and arrangements have been made for these purposes. There is now a section for mathematics and the various natural sciences, and its programme, as well as the issue of a revived "Proceedings," are in the hands of a special committee, consisting this session of Prof. P. F. Kendall, Dr. Harold Wager, and Prof. R. Whiddington. The 106th session of the Society was opened on October 20 with a presidential address by Prof. W. Garstang on "Wordsworth Interpretation of Nature." There was a meeting of the scientific section on November 3, and there will be another on January 27. On February 10 next, Prof. D'Arcy W. Thompson will lecture on "The Labours of Hercules and their Astronomical Significance."

ELECTROPLATERS and electrodepositors have long felt the need for a society in London in which they could discuss problems arising from their work and could come into contact with scientific electrochemists, particularly those engaged in research work on electrodeposition. At the suggestion of the Council of the Faraday Society, a small provisional committee was recently formed to take steps to found an Electroplaters' and Depositors' Technical Society, and a meeting to inaugurate this Society will be held on Wednesday, November 11, at 8.15 P.M., at the Northampton Polytechnic Institute, Clerkenwell, London, E.C.1. All actively engaged in some responsible position in electroplating, or in the art of electrodeposition, are to be eligible for membership, and it is suggested that there should be two types of meeting: (1) Meetings at which lectures will be given, or papers read, followed by discussion. The papers presented would be offered for publication to some suitable technical journal. (2) Informal discussions opened by a short paper. The latter meetings would be attended by members only and no report would be published. In view of the desire of the electroplating trade to have a link with a scientific body and to be associated with the name of Faraday, the Council of the Faraday Society has agreed that the new Society be described as "Associated with the Faraday Society," provided that it has representation on the committee. The acting honorary secretary of the provisional committee is Mr. F. S. Spiers, secretary and editor of the Faraday Society, 90 Great Russell Street, London, W.C.2

IN the issue of NATURE of October 17, p. 574, Fig. 4 of Major Burnett's letter on "Bordered Squares of Fifth Order and their Magic Derivatives" was erroneously not magic in one of its diagonals. The square should be

24	14	18	1	8
(17)	(6)	(15)	20	7
(16)	(10)	(12)	23	4
(5)	(25)	(11)	2	25
3	13	9	19	21

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: An experimental officer in the Acoustical Experimental Section of the War Office—The Secretary, Royal Engineer Board, 16 Grosvenor Gardens, S.W. 1 (November 8). A travelling lecturer in electrical

engineering under the Glamorgan Education Committee—The Chief Education Officer, County Hall, Cardiff (November 10). A lecturer in the department of mathematics and mechanics of the Technical College, Sunderland—Chief Education Officer, 15 John Street, Sunderland (November 17). A lecturer in the department of education of King's College, London—The Secretary, King's College, Strand, W.C. 2 (November 18). A senior and a junior investigator in the department of metallurgy of the University of Sheffield for work on the electrodeposition of metals—The Registrar, University, Sheffield. A lecturer and demonstrator in the mechanical engineering department of the Borough Polytechnic Institute—The Principal, Borough Road, S.E. 1. A commercial assistant to the director of the Electrical Research Association—The Director, B.E. & A.I. Research Association, 19 Tothill Street, S.W. 1.

Our Astronomical Column.

COMET 1925a (SCHAIN, COMAS SOLA)—Prof. J. Comas Sola, of Barcelona, one of the discoverers of this remarkable comet, has now succeeded in detecting it in the morning sky on its emergence from the sun's rays, which have concealed it for several months.

The position is as follows

	UT	RA 1925.0	S Decl	Mag
Oct 18 ^d	4 ^h 38 ^m 25 ^s	10 ^h 22 ^m 10 ^s .6	5° 48' 22"	12.5

The correction to his ephemeris is -20^s , $-4'$ 6", which is satisfactorily small. This has been applied to the following ephemeris (for 0^h)

	RA	S Decl	log r	log Δ
Nov 9	10 ^h 17 ^m 33 ^s	8° 17'	0.6288	0.6560
17	10 13 59	9 13	0.6299	0.6428
25	10 9 4	10 10	0.6312	0.6286

The comet, which has the largest perihelion distance known, is now slowly receding from the sun, but approaching the earth fairly rapidly. There is reason to hope that it will be followed for another year, perhaps longer, which should permit accurate determination of the departure of the orbit from a parabola.

LARGE DETONATING FIREBALL.—Mr. W. F. Denning writes: "On October 22 at 10 h. 44 m. P.M. a brilliant fireball was observed at many places in Ireland. As observed from Co. Waterford, its path was from west to east from a few degrees below Polaris towards a point a few degrees below Castor and Pollux. The nucleus at first displayed an intense electric-blue colour and then burst into a strong, red, egg-shaped mass. As seen from Antrim, the meteor with its glare lit up the whole country and apparently had a disc as big as the full moon. Six and a quarter minutes after the object had disappeared, the observers distinctly heard two heavy thuds like the distant report of heavy artillery, followed by a prolonged rumble akin to thunder. The duration of flight was about five seconds, but the observer at Waterford did not listen for any sound, while at Antrim it was specially awaited so that the time interval given (6½ minutes) may be depended upon as being correct. This estimate corresponds to a distance of about 75 miles. It is hoped that further observations will come to hand so that the real path of this fine object may be computed."

WOLF'S NOVA IN AQUILA.—Dr. W. H. Steavenson gave an account of this remarkable object at the

October meeting of the British Astronomical Association. A slide was shown from a plate of the region taken at Königstuhl about a year ago. This showed stars as faint as mag. 16.5, but there was no trace of the supposed Nova, which is not found on any plates taken there until September 1925. It is possible, however, that study of the Harvard plates may reveal more about the circumstances of its rise. It has been well observed in England by the B.A.A. Variable Star Section. Since discovery, its magnitude has fluctuated between 8.6 and 9. There seemed to be a tendency to decline, but this was followed by a slight recovery.

The spectrum has been studied with an objective prism at Babelsberg Observatory, Berlin. It was continuous, apparently without visible lines, bright or dark, from the distribution of intensity of light, its spectral type was concluded to be approximately G. The star is outside the main stream of the Milky Way, but in one of its faint extensions.

THE TURKISH CALENDAR.—The Turkish Calendar has hitherto been a very singular one. It simply consists of 12 lurations, or 354½ days. There is no intercalary month, such as was inserted (seven times in nineteen years) by most of the ancient nations which used lunar months, consequently the beginning of the year travels right round the solar year in about thirty-three years.

The following data are quoted from the Nautical Almanac

Year	Turkish Year begins	Ramadan begins
1922	Aug 24	Apr 28
1923	" 14	" 17
1924	" 2	" 6
1925	July 22	Mar 26

These are not the dates of new moon, but about two days later, since they await the visible crescent.

The Times of October 26 contains the welcome announcement that a bill for the adoption of the Gregorian Calendar will shortly be laid before the Grand National Assembly. Its adoption would render the use of the Gregorian Calendar general through Europe. It will be remembered that Greece recently adopted a calendar practically identical with it, though it was decided to use the true moon instead of the ecclesiastical moon in computing Easter.

Research Items.

JAPANESE BATTLEDORE AND SHUTTLECOCK.—Mr. Stewart Culin, in the *Brooklyn Museum Quarterly* for September, illustrates and describes a number of Japanese battledores and shuttlecocks, which are used in the shuttlecock play of girls in the streets on New Year's Day, according to an old custom universal among high and low all over Japan. The battledore (*hagonta*) is a flat wooden bat brilliantly painted, or covered with crape pictures in relief. Those much sought by collectors are old ones used by girls of rich families, and they are covered with conventional pictures on a plaster ground and bear family crests. The pictures on many of these of archaic design are conventionalised and broken down court scenes which are connected with the Sagicho ceremony. This was one of the most important annual celebrations in the Japanese Court, occurring on the 14th, 15th, or 18th day of the first month, when the New Year decorations were burned. Comparison of a number of designs shows that the battledore as it now exists was derived from similar objects used in court ceremonial. The shuttlecock is now a seed with feathers attached to a bamboo splint stuck in the seed or with the feathers stuck directly into the seed itself. It clearly suggests a plum blossom. In a catechism published in 1544 the shuttlecock is said to be a charm against mosquito bites, and it is compared in its flight and appearance to the dragon fly, which catches and eats the mosquito.

A GEBER DISCOVERY.—In the *Archiv für Geschichte der Medizin* (Bd 17, Heft 4, 1925) Dr. Ernst Darmstaedter announces an extremely interesting and important discovery in connexion with what has come to be known as the "Geber problem." The identity of Geber with Abū Mūsā Jābir ibn Ḥayyān (about A.D. 750–800) has already been sufficiently proved; the outstanding question is whether the Latin works of Geber are translations from Arabic works of Jābir. Arabic influence in the *Summa perfectionis* and in the other books is very obvious, but no Arabic originals have hitherto been discovered. In a thirteenth-century manuscript at Florence, however (Cod. Riccardianus 933, Lii 9), Dr. Darmstaedter has been fortunate enough to find a Latin translation of the Book of Mercy (*Kitāb al-Rahma*), which is an expansion of one of Jābir's books by a follower of his, and of which the Arabic text has been published, with a French translation, by Berthelot (*La Chimie au moyen âge*, tome 3, Paris, 1893). The importance of this discovery lies in the fact that the manuscript contains also, and in the same hand, the *Summa perfectionis* of "Geber" and the *Liber Geberis de investigatione perfectionis magisterii*. It is thus clear that the celebrated *Kitāb al-Rahma* existed in a Latin form more than 600 years ago, and the association of it with the *Summa* and *De investigatione* in the same manuscript is at least strong presumptive evidence that these too may well be, in the main, authentic translations from the Arabic, as they were for so long considered to be. Dr. Darmstaedter's discovery raises even higher the hope that a diligent search may yet bring to light the Arabic texts of the Latin treatises.

PRESERVATIVES FOR NATURAL HISTORY SPECIMENS.—Prof Gordon E. Gates, professor of biology in the University of Rangoon (Judson College), asks for information on the use of a tincture of calabar bean as a preservative for natural history specimens, referred to by a correspondent in *NATURE* so long ago as October 20, 1881 (vol 24, p. 583). Major E. E. Austen, Natural History Museum, South Kensington, has been good enough to favour us with the follow-

ing information upon the subject: "The use of a tincture of calabar bean as a preservative for entomological and other natural history specimens, although strongly urged by the writer of the note to which Prof Gates refers, would seem to be nowadays practically, if not entirely unknown. The seeds of the calabar bean (*Physostigma venenosum*, Balf.) are highly poisonous, the alkaloid physostigmine, which constitutes the active principle, having a depressant action on the spinal cord. As a preservative from the attacks of destructive insects, for use in museums and entomological cabinets, the strength of the tincture was given as 'one part of the bean to eight of (rectified?) spirit,' the mode of employment being, in the case of Lepidoptera, to place a drop of the fluid on the body of the specimen. As regards entomological collections in the tropics, especially during the rainy season, mould is often a more formidable foe than even ants, book-lice (Psocidæ) or certain beetles. The risk of mould as well as damage by insects may, however, be entirely prevented by thoroughly rubbing the inside of the box into which the specimens are pinned with a piece of sponge, or swab of cotton-wool, soaked in a saturated solution of naphthalene in chloroform, mixed with an equal quantity of ordinary medical (beechwood) creosote. The inside of the box should be rubbed with the mixture until the cork-lining shows through the paper, but the fluid must not be allowed to touch the specimens, or they will be injured."

HERMAPHRODITISM IN DECAPOD CRUSTACEA.—Until recently it was believed that all decapod Crustacea were of separate sexes. Wollebaek described the occurrence of normal functional hermaphroditism in the deep-sea thalassinid *Calocaris* in 1909 and Spitschakoff in the prawn *Lysmata* in 1920. Sven Runnstrom (Beitrag zur Kenntnis einiger hermaphroditischen Dekapoden Crustaceen. Bergens Mus. Skr., ny Raekke, Bd 3, No. 2) has now made a detailed study of *Calocaris*, and describes the histology and cytology of the gonads in all the phases of development. At first no difference can be observed between the germinal cells, but at an early stage the anterior and posterior ends of the gonad begin to show the development of oocytes while the middle part assumes the character of a testis. The development of the ovarian regions lags behind that of the testicular portion, which grows out into numerous follicles within which spermatozoa are produced. When the male phase has been passed through the follicles dwindle and oocytes begin to appear in the middle part of the gonad, the whole of which in the final phase functions as an ovary. It is noted that, in the middle part, oocytes are produced from germinal cells which have lain dormant while neighbouring cells, at first indistinguishable from them, have gone through the stages of spermatogenesis. The author has also investigated certain other decapods, especially the crayfish *Parastacus*, in which rudimentary non-functional hermaphroditism occurs constantly. The general structure of *Calocaris* shows no preponderance of the characters of either sex. It is a true hermaphrodite, a mosaic of the two sexes. Many interesting details are given of the habits of the animal as observed in an aquarium. *Calocaris* appears to feed exclusively on the mud in which it burrows. It was found to seize fragments of mussel offered to it, but, instead of eating them, it buried them inside its burrow, where their decay speedily enriched the surrounding mud with swarms of Infusoria. No doubt the culture so manured served later as food for the crustacean.

BACTERIOPHAGE AND PLANT DISEASE ORGANISMS.—According to a recent paper by G. H. Coons and J. E. Kotila, plant bacteriologists have also to take into account the d'Herelle phenomenon, and lytic principles may be demonstrated which have an inhibiting effect upon the growth in pure culture of organisms responsible for various plant diseases (*Phytopathology*, July 1925). These lytic principles may be increased in effectiveness by "growth" upon the cultures they destroy, the filtered extract of these cultures, sterile as regards contained organisms, proving more efficient as a lytic agent than the original extract used to inoculate the culture. The authors suggest that such lytic principles may be widespread in Nature and may account for the disappearance of a pathogen from a heavily infected soil. By smearing such a lytic principle over sterile slices of carrot they protected these slices against the rotting effects of the well-known *Bacillus carotovorus*. Such organisms are so readily experimented with in culture that if further work should confirm these results, we may anticipate a considerable study of the d'Herelle phenomenon by experimental investigation with the organisms causing "soft-rots" in vegetables.

CROWN GALL IN PLANTS AND CANCER.—It will be recalled that Erwin F. Smith has directed attention to the secondary gall-like growths sometimes formed in plants after infection by *Bacillus tumefaciens*, and suggested that they owe their origin to the permeation of the normal tissue by "tumor strands," growing from the original gall in an analogous manner to that in which human cancer may spread. Furthermore, E. F. Smith, in an account of his recent tour round European centres of cancer research (*Science*, April 17 and June 12, 1925), has briefly indicated that German workers upon cancer are now obtaining very interesting results in work upon animals inoculated with an organism which is said to be indistinguishable from that found in the crown gall of the plant. The Manchester workers Robinson and Walkden (*Nature*, June 23, 1923, p. 858) were unable to confirm Smith's account of the origin of these secondary tumours in the case of crown gall on plants, and now Michael Levine publishes (in *Phytopathology*, August 1925) the results of extensive studies of crown gall, in which he finds that secondary tumours and strands are only formed in very young tissues and result from the growth and elongation of these immature tissues. They begin to form simultaneously with the crown gall at the seat of inoculation, and are in no sense the result of the permeation of normal tissues by subsequent strands of "malignant" tissue.

THE SYSTEMATIC POSITIONS OF THE PTERODACTYLA AND CHELONIA.—In the *Bulletin of the Geological Institution of the University of Upsala*, Vol. 19, 1925, appear three papers of great interest, two by Prof. Wiman on the Pterodactyla and one by Dr. Zdansky on the Chelonia. Prof. Wiman, writing on Dorygnathus and other pterodactyles, gives a full description of the skeleton together with illustrations. In discussing the systematic position of the group he is unable to accept its usual derivation from some form in the neighbourhood of the Pseudosuchia and considers that the Pterodactyla, although having two temporal vacuities, are not really diapsid in skull structure since the arrangement of the bones surrounding the vacuities is not strictly comparable. As to the real ancestry of the group, apart from a mention of Araeoscelus, the author prefers to take a non-committal and waiting attitude. Prof. Wiman's second paper deals with the probable life habits of the pterodactyles. Dr. Otto Zdansky's paper, also with numerous figures, deals with the temporal region

of the skull of the Chelonia in support of his thesis that the skull structure of the Chelonidea is a secondary condition.

VARIATIONS OF SEA TEMPERATURE AND SALINITY.—In the *Bulletin Hydrographique* for 1924, recently issued by the Conseil Permanent pour l'Exploration de la Mer at Copenhagen, there are published tables showing variation in salinity and temperature of the sea with position, season, and depth, being the data collected by the participating countries in the Atlantic, North Sea, and Baltic. The region between North Ireland and the African coast, including the English Channel, is dealt with in the *Rapport Atlantique*. The degree of saturation with oxygen and the hydrogen ion concentration of the water is given for a number of positions. The lowering of the hydrogen ion concentration in the upper layers to which light penetrates, owing to the utilisation of carbon dioxide by diatoms, is very clearly shown. No deductions, drawn from the collected data, are published in the *Bulletin* concerning the flow of the ocean currents, their seasonal variations or fluctuation year by year. Such fluctuations are of particular interest in fishery research. A bibliography of the year's publications by workers in the different countries is included, and of these a fair share now comes from Great Britain.

PRODUCTION OF LOW FREQUENCY OSCILLATIONS.—We recently published in *Nature* (vol. 116, p. 244) a letter from Mr. C. Constançon describing a device for obtaining low frequency oscillations. He used a three-terminal thermionic valve and instead of varying the inductance in the ordinary way by altering the position of the iron core, he varied it by means of direct current excitation. One obvious advantage of this method is that we maintain the symmetry of the inductance of the circuit. In connexion with this method we have received a letter from Prof. D. Mazzotto, of Modena University (Italy), in which he describes an invention which he calls "le triode melodique." This device, which was described in *Scienza per tutti* for May 1, 1924 (p. 134), and March 1, 1925 (p. 76), enables us to get variable low frequency oscillations even more simply. He uses the same kind of valve and a low frequency transformer with an iron core. By touching the plate wire to the various terminals of the high-tension battery, various notes are heard in the telephones. Instead of using the terminals of the battery it is better to make a potentiometer arrangement, so that the sound can be continuously altered. By using a suitable key any piece of music can be produced in this way. The principle of the method seems to be the same as that described by Constançon.

ELASTIC HYSTERESIS IN ROCK SALT.—Experiments have been recently carried out by Messrs. M. Polanyi and G. Sachs on rods of rock salt supported at the ends and weighted at the centre (*Zeitschrift für Physik*, August 22). The load was applied by means of a float in a vessel from which the water could be allowed to run off slowly, and simple polished rods of rock salt and others which had been heated to 600° C. were employed. With the polished rods the first observable permanent deformation took place with less than 500 gm. per sq. mm., and the rods broke with more than 1000 gm. per sq. mm. With the heated rods the deformations were larger, and the elastic limit was certainly below 200 gm. per sq. mm., but in both cases it was found that the more accurate were the methods of measurement the lower were the loads with which permanent alterations of form could be shown to exist. When the load on either kind of rod is slowly removed, and then slowly reimposed,

the load deformation curve does not repeat itself, and if this process is repeated several times between the same load limits, the curve forms a hysteresis loop somewhat similar to that observed in magnetisation, but with the difference that the "elastic" alterations of form on loading are proportional to the tension, but not when the load is reduced step by step. It is also shown that, when the surface layers of the plastically bent crystals are dissolved in water, movements result which show the existence of internal stresses.

THE DEBYE-SCHERRER RINGS OF DEVELOPED PHOTOGRAPHIC PLATES.—Messrs. R. Blunck and P. P. Koch, in the *Annalen der Physik* for September, describe a series of measurements of the Debye-Scherrer rings produced by a practically monochromatic beam of X-rays, using a preparation formed by exposing a photographic dry plate in strong daylight and developing it. The film was separated from the glass and fifteen discs were cut from it and superposed so as to form a little plate about 0.23 mm. thick. This was placed at the centre of the camera in the path of the X-ray beam, and a well-defined ring system was obtained indicating a face centred cubic lattice, with 0.403 Å.U. for the edge of the elementary cube, in good agreement with Vegard's value for silver. An inner ring was shown to be due to gelatin. Measurements of the broadening of the rings due to the fineness of the particles showed that the silver crystals were not smaller than 2.4 Å.U. It was possible to calculate the amount of silver in a single layer from the absorption of the X-rays, it amounted to 0.00065 gm. per sq. cm. The value obtained from the blackening, using the formula of Hurter and Driffield, was 0.00080 gm per sq cm.

UTILISATION OF FISH REFUSE.—An account of the uses of fish by-products in industry is given by A. C. Hopper in the *Chemical Trade Journal* of October 2. Fish meal which has been freed from oil is used for feeding live-stock, as a fertiliser, and as the basis of a plastic for making small moulded articles. Fish glue is widely used on account of its heat-resisting qualities, but freedom from chlorides and protein matter is essential for a good quality glue. Fish oils are used in tanning and in medicine. Oil tanning of skins requires an oil which is easily oxidised, having a high fatty-acid content. Fish oil yields excellent heat-resisting paints when used with tungate driers; drying is rapid if the oil is properly treated and has a low fatty-acid content. Fish oil free from sulphur can be hardened by hydrogenation, giving fats for soaps, candles, and margarine. Fish skins are used in the manufacture of a high quality leather. Further uses for fish products are the manufacture of printers' ink, enamels, lubricants, tool-hardening oils, and tarpaulins.

THE TRANSMUTATION OF METALS.—In *NATURE* last year (vol. 113, p. 459), Prof. Nagaoka, of Tokyo, gave his reasons for believing it possible by subjecting mercury to an intense electrostatic field to drive off from the nucleus of the atom a hydrogen nucleus and to add an electron and in this way produce gold. Since then (*NATURE*, July 18, 1925, p. 95) he has outlined his preliminary results. In the July issue of the *Journal de Physique* he describes his experiments in more detail. The mercury purified in the usual way was distilled two or three times in vacuo at 200° C. before use. It formed the lower electrode in a porcelain flask containing paraffin oil into which the upper electrode of iron dipped. The discharge was obtained from an induction coil giving a spark of

120 cm., and the author estimates the field above the mercury as of the order of 150,000 volts per cm. The discharge was maintained for 4 hours, and the black paste produced in the flask analysed for gold, which was found in minute particles. On heating small pieces of glass in the paste, they became ruby glass identical under the microscope with the ruby glass obtained from gold in industry.

PLATINUM.—A survey of the platinum metal industry by G. Malcolm Dyer appears in the *Chemical Age* of October 3. Most of the commercial platinum is obtained by careful washing of alluvial deposits; the material obtained in this way contains in addition, palladium, osmium, iridium, rhodium, and ruthenium. Tasmanian ore consists almost wholly of the alloy osmiridium. The anode slime from copper refining is another source of the platinum metals. The method of cupellation is no longer used in their separation, but the ore is treated with aqua regia, when platinum, palladium, rhodium, and some ruthenium and iridium dissolve, leaving the osmiridium. The osmiridium is alloyed with zinc and the product dissolved in aqua regia. Osmic acid is distilled off in superheated steam and the remaining acid liquor treated with ammonium chloride, and on standing, ammonium chloroiridate is precipitated, leaving ruthenium. The platinum liquor is treated with ammonium chloride, the chloroplatinate filtered off, and on standing the chloroiridate is precipitated. These salts yield the metals on heating. The remaining liquor is treated with zinc, the black mud filtered off and treated with dilute acid. On treatment with dilute aqua regia, only palladium dissolves, leaving rhodium with a trace of ruthenium. The residue is fused with barium peroxide, treated with aqua regia, and separated by means of the ammonium salts. The fusion of the metals is carried out in a furnace of lime in the oxyhydrogen blowpipe flame.

CONSTITUTION OF BINARY ALLOYS.—In a recent paper by K. Honda and T. Ishigaki (*Science Report of the Tohoku University*, vol. 14, No. 3, p. 219), on the depression of the freezing point of a metal by the addition of a second, an attempt has been made to extend the pioneer work of Heycock and Neville. The present research appears to have been very carefully carried out and affords valuable information in two directions. In the first place the authors offer good reason for the belief that, at any rate in the binary systems which they have studied, the solute metal is always in the monatomic state both where a eutectic and also where a solid solution is formed. In the iron-carbon system it is not clear whether the authors are correct in believing that the same state of affairs holds, since an unassociated iron-carbide, such as Fe₃C, would not be excluded by the results given. The second portion of the work deals with an investigation of the agreement of observed depressions of the solidification point with Planck's formula. The lowering of the freezing points of pure metals is shown to be proportional to the concentration of the added metal, so long as the solution is dilute. The atomic depression is independent of the nature of the solute, and of whether it forms a solid solution or not, and Planck's equation is shown to hold. The latter expression is used to obtain values for the latent heat of fusion of the solvent metal, and results are obtained in good agreement with those of direct observation. Since the latter are not always easily measured, it is possible that the new values are more reliable than older ones. The means of all the results recorded are:

Ag	Al	Bi	Cd	Cu	Pb	Pt	Sb	Ni	Sn	Zn	Au
24.0	81.3	12.5	12.2	41.7	5.85	26.7	38.7	51.9	14.3	26.0	15.3

The New Statutes of the University of Cambridge.

THE statutes of the University of Cambridge proposed by the University Commissioners were made public about a week ago. They occupy no less than sixty-nine pages of the *University Reporter*. Throughout they afford ample evidence of careful drafting, the final result of much deliberation and discussion.

We are not here concerned with such changes as the institution of a house of residents, or with the fact that in future the vice-chancellor is to be elected for a period of two years in the first instance, but rather with such proposals as will affect the various departments of science in the University. In many ways the proposed organisation will change scientific faculties far less than others. Each science school has been a financial unit for a long time; it has in practice organised all formal teaching in its own subject, and the more junior appointments (that is, demonstratorships) have been made by the professor. In most other branches of study, however, much has in the past been done by the colleges. They have financed and appointed their own lecturers, professors having no direct control in the matter. Until recent years many courses of college lectures were not immediately available to members of all colleges. Under the new scheme all formal teaching will be directly controlled by the University.

In the past the General Board of Studies was the co-ordinating body, and it worked through a system of special boards. Membership of the latter might be *ex officio* as in the case of professors, readers, and examiners, or upon nomination by the Council of the Senate, or by grouped junior members of departments. In the future there is to be a general board of the faculties with the powers of the old board, and in addition (presumably subject to the approval of the financial board) control of the salaries of the junior appointments. Eight of its thirteen members are to be elected by the faculty boards. Special boards are to be replaced by faculty boards, membership of which, *ex officio*, is limited to professors or heads of departments. Elected members are to be chosen by ballot at a general meeting of the faculty concerned.

These changes are important, because the powers of the new bodies are considerably greater than those of their predecessors. In addition to routine work, they will elect members of the new appointments committees which will appoint lecturers and demonstrators; they will have the power to institute and appoint to probationary lectureships, and to make recommendations to the general board on the subject of the salaries of the junior members of the staffs. From this system an increased uniformity in the scientific departments should result. In the past, the larger and less embarrassed departments have often been able to grant their staffs higher emoluments than have some of those the finances of which were more straitened. There is a prospect that the co-ordinating general board will now be in a position to ensure for equal work a reasonably uniform standard of remuneration in all faculties and departments.

It is difficult to forecast future events, but the intention of the Commissioners has evidently been to frame a constitution by which the junior members of a faculty can have the opportunity of securing reasonable representation on their board. Past experience has shown that, in the matter of nominating members of special boards, the junior staffs are often as apathetic as is the ordinary man in electing guardians of the poor. The Commissioners propose to

ensure that the machinery shall be there. They can do no more.

It may appear that undue stress has been laid on the financial powers of various bodies, but the strength of the University largely depends on its retaining the younger men most fitted for its purposes and in the past this has sometimes, for financial reasons, been difficult. The stipends of junior members of staffs are usually small, and unless accompanied by fellowship dividends are scarcely sufficient to allow a man to marry unless he happens to have private means. Outside work of some kind or other is usually obtainable, but frequently so much of it has to be done that there is little time left for the all-important research. The Commissioners are endeavouring to avoid this evil by making colleges reserve a proportion of fellowships for University officials, and further by permitting extra remuneration to be made to non-fellows. Time will show whether there is enough money available to implement these policies.

If the necessary funds are lacking, some non-fellows will be in a difficult position, as the University Commissioners, in their endeavour to avoid "sweating," have laid down a maximum number of hours of private teaching which may not be exceeded by university officers. A probationary lecturer giving one course of lectures, for which he will be entitled to draw a "basic" salary of about 160*l.*, will, if he is not a fellow of a college, find little by way of gilt on his gingerbread. The whole financial situation is obscure, faculties controlling few students will presumably have to be subsidised from the University exchequer, as are some scientific departments at the present time. It will be interesting to observe if any faculty can provide a surplus. Expected surpluses have a way of failing to materialise.

The conditions of tenure of various offices are to be changed. Professors are to retire at the age of sixty-five. This decision has been arrived at after several changes of policy. The original commission advocated it. The present one, after publishing an interim account of its intentions, in which it stated that it would increase the retiring age to seventy in certain circumstances, has now reverted to the first proposal. This change of plan threatens to do an injustice to any recently appointed professors who, assuming that seventy was the final decision, on accepting their new posts agreed to come under the provisions of the new statutes. Presumably adjustments will have to be made in such cases.

Lectureships are to be tenable for three years in the first instance, but on reappointment they are in general to continue until the retiring age. There are some who consider that this security of tenure may lead to doubtful efficiency, but as a lecturer's stipend will in the future depend chiefly on the amount of work he does in the department, their fears are probably groundless.

Demonstrators are to be appointed for three years, and are in no case to hold office for more than eight years. The underlying idea is that at the end of the latter period the faculty board will have to face the necessity of creating a new lectureship for a man if it wishes to retain his services. This will mean that each case will be carefully scrutinised, men of uncertain value will be sorted out on the one hand, and on the other, those of ripe middle age and undoubted distinction will no longer have to carry the somewhat juvenile title of demonstrator. On paper it seems as

if the whole scheme should work satisfactorily provided that it is not beyond the limits of the University chest

A change is contemplated in the organisation of biological faculties. The old special board of biology and geology consisted of twenty-eight members. Under the new scheme there will be two faculties, namely, Biology "A," including anatomy, botany, genetics, geology, parasitology, and zoology, and Biology "B," comprising biochemistry, pathology, physiology, with experimental psychology added. For certain purposes a "School of Biological Sciences" will be formed. It seems a little doubtful if any good result will be achieved by this splitting of what was a fairly natural grouping, if a large one.

The primary duty of the Commission was to adjust the relations of the University and the colleges, this has been done not only in the provision of reserved fellowships and in the centralisation of teaching activities, but also in the matter of contributions from the colleges to the University chest. In the

past, the colleges together have had to pay such a percentage of their combined incomes as provided the sum of 30,000*l.* per annum. In the future, definite rates of taxation are proposed by which the poorer colleges will pay less and the larger ones will pay more than heretofore. On the other side, the colleges are relieved from paying contributions on income derived from students. There are adjustments to be made during the transition period, and a rough calculation suggests that at first the sum due from collegiate sources will not greatly exceed the 30,000*l.* As the new order comes in, there should be an increasing sum available, and further, as colleges become more wealthy owing to benefactions or husbanded resources, the University will in its turn be able to expand its activities. It is too much to hope that the University will ever cease to be an active beggar, but the anomaly of the underpaid university officer serving through a university organisation the requirements of colleges, some outstandingly wealthy, should be removed.

International Meteorological Research.

THE Meteorological Section of the International Union of Geodesy and Geophysics met at Madrid at the beginning of October 1924, and the proceedings of the Section edited by the secretary, Prof Eredia, have now been published. Some doubt had been felt by those familiar with international meteorological organisation as to whether the Meteorological Section of the Geophysical Union could find a broad enough field of operations without encroaching upon the proper domain of the International Meteorological Committee. The report of the work of the Section at Madrid which is contained in the present volume ought to remove any doubt of this kind. There are points where the work of the Section touches the work of the International Meteorological Committee, and under the guidance of a president less familiar than Sir Napier Shaw with international meteorological organisation, the Section might have wasted a certain amount of time in the unprofitable discussion of questions belonging to the field of official administration. The minutes of the five meetings, one of which was held conjointly with the Sections of Hydrology, Oceanography and Terrestrial Magnetism, show that the Commission confined itself to the encouragement and development of experimental and exploratory work in meteorology.

One of the most important decisions, afterwards confirmed by the Union in general session, was to provide for the issue of a specimen volume of the observations of the upper atmosphere for a single year, collected from all the world. It is understood that this volume is now in course of preparation, and will represent a great advance not only in regard to the number of observations included but also more especially in regard to their presentation for scientific discussion.

Another important decision arose out of a discussion on the question of the establishment of an International Bureau. It was decided to make a subvention to an existing meteorological service for the execution of a piece of work of the kind that an International Bureau might be expected to undertake. Mr. la Cour, director of the Danish Meteorological Institute, was entrusted with the work selected, which consists in the preparation of an atlas of daily or twice daily synoptic charts for as large a portion as possible of the Northern Hemisphere for the third quarter of the year 1923.

The appendices to the proceedings contain some interesting proposals and some valuable data. The American delegates presented, among other things, a proposal to adopt Dr Marvin's suggestion for improving the Gregorian calendar. The suggestion is, briefly, to have a year of 13 months and a quarter of 13 weeks. There would be an odd day to dispose of in ordinary years and 2 days in leap years. The Commission approved of having 52 weeks in the year, one of the weeks being a week of 8 days, and decided to recommend the Advisory and Technical Committee on Communications and Transit of the League of Nations to take into consideration as soon as possible the simplification of the Gregorian calendar. In a matter of this kind there does not appear to be special need for urgency, the need appears to be rather for discussion and deliberation. A change in the calendar is, and ought to be, an infrequent event, but when a change is made it ought to be as much of an advance as humanity can stand. It seems a pity that the Commission did not tackle the question of the length of the week, it is fundamental. There appears to be no reason why the 7-day arrangement which commended itself to pastoral oriental people 3000 years ago should be suited to western urban civilisation of to-day. Many facts indicate that it is not. A break at the end of 6 days is too soon for the man who has a piece of work in which he is really interested, it is too late for the man who is not specially interested in his work. Consequently the latter, nowadays, usually has a mid-week half-holiday. A 10-day week with a secular mid-week holiday might be better for all concerned. It would save us from the numerical inconvenience and the ill omen of 13 months in the year.

Another appendix deals with the subject of radiation in relation to meteorology. A table giving the radiation of black earth at various temperatures will prove most useful for reference by all students of meteorology and ought to find its way into all standard collections of meteorological tables. The tabulated values of actual radiation recorded at various places, given on pp 94-121, provide the first systematic collection of observations of radiation, and their issue should lead to the adoption of an international form for the publication of such records in future. The variety of forms and units now in use is an obstacle to research which might well be removed.

E. GOLD.

Suggestion and Personality.

A PAPER with the above title was read by Dr William Brown before the Psychological Section of the British Association at the recent meeting at Southampton. Dr. Brown holds that the two forms of theory and practice in the field of psycho-therapy, namely, suggestion and auto-suggestion on one hand, and mental analysis (including the special Freudian system of psycho-analysis) on the other, can be harmonised, and that a sound system of psycho-therapy should satisfy the more moderate claims of both.

Different views are held by psychologists as to the relationship of suggestion to hypnosis. According to the Salpêtrière School (Charcot, Janet), hypnosis is an artificial hysteria or mental dissociation. According to the Nancy School (Bernheim, Coué, Baudouin), hypnosis is a state of artificially increased suggestibility. According to the Freudian School, suggestion is explained in terms of "transference," and when symptoms are removed by suggestion treatment, no real cure has been produced, but the symptoms have merely been replaced by another symptom, namely, psycho-sexual dependence of the patient upon the physician.

Dr. Brown, as a result of his experiences with hundreds of shell-shock cases, agrees with the definition of the Salpêtrière School, as he found that his patients were readily hypnotisable and in direct proportion to the degree of their mental dissociation. Further, the suggestibility, though certainly increased in milder degrees of dissociation, was often conspicuous by its absence in more pronounced degrees of dissociation. Dr. Brown also holds the view that the Freudian theory is refuted by the facts of auto-suggestion as well as by the working of suggestion in very early life, before the fact of transference could have any validity. It was admitted, however, that the question of whether suggestion is always a libidinal relationship is not entirely free from doubt, especially in view of an original and important theory by Dr. Ernest Jones, who explains all suggestion in terms of narcissism.

In conclusion, the relation of suggestion and auto-suggestion to the will was considered. It has been noted that in the attempt to recall a forgotten name, anxious effort to remember generally brings failure. Coué would explain this by his so-called Law of Reversed Effort. "When the will and the imagination are in conflict the imagination always wins." Dr. Brown's view is that such a formulation is only true of states of incomplete will where fear of failure has prevented the full development of volition. Most cases of successful auto-suggestion are characterised by avoidance of thoughts and fears of failure, and may therefore be considered as instances of supplementation and completion of the volitional process by means of adequate control of the imagination.

Finally, auto-suggestion must be supplemented extensively by what Dr. Brown terms "autognosis." In the course of mental analysis the patient obtains a more and more objective view of the past course of his mental life. He understands more clearly in what respects he has failed in the past to adjust himself adequately to the demands of life and to the peculiarities of his own nature. This process of intellectualisation of the mind is one of the most important factors of cure in the course of mental analysis. By such a course the patient is rid of complexes and other dissociations and is thus enabled to face the world with a unified personality.

University and Educational Intelligence.

CAMBRIDGE.—Mr. A. B. Ramsay, lower master of Eton, has been appointed master of Magdalene College in succession to the late Dr. A. C. Benson.

The General Board of Studies has approved that the degree of doctor of science shall be conferred on Mr. H. Hamshaw Thomas, lecturer in botany, who has for some years been engaged in investigating fossil angiosperm plants of Jurassic age from the Yorkshire coast.

Prof. V. H. Blackman, of the Imperial College of Science and Technology, has been appointed an elector to the chair of botany in succession to the late Sir Francis Darwin.

Permission has been given for the sealing of the conveyance of the site for the new University Library. Plans for the proposed building have been exhibited for some time past, but very generous benefactions will have to be forthcoming before they can be carried out.

EDINBURGH.—Prof. J. A. S. Watson has intimated his desire to resign from the chair of agriculture and rural economy at the end of the autumn term, as he has been appointed to the Sibthorpe chair of rural economy in the University of Oxford.

LONDON.—By the will of the late Sir Rickman Godlee, Bart., after the death of his wife, one moiety of his residuary estate is given to University College, and the other moiety of his residuary estate to University College Hospital. By a bequest from the late Miss L. S. Gibbs, 150*l.* per annum is to be devoted to the establishment of a studentship in memory of her mother, to be called "The Laura de Saliceto Studentship," for the advancement of cancer research either on the physiological or the chemical side.

The following doctorates have been conferred:—D.Sc. (*Chemistry*), Mrs. E. H. Ingold (Imperial College—Royal College of Science and the Royal Holloway College) for a thesis entitled "Tautomerism"; D.Sc. (*Geology*), Mr. A. K. Wells, for a thesis entitled "The Geology of the Rhobell Fawr District (Merionethshire)," and other papers.

MANCHESTER.—Through the generosity of Mr. Ernest A. Knight, honorary treasurer of the University, a selected medical graduate will be enabled, this winter, to visit the United States, where he will study and, eventually, report upon the methods used in approved institutions, and investigate the part played by mental factors in the development, treatment, and cure of mental disorders. The competition was open to those who had obtained or had entered upon a course for the Diploma in Psychological Medicine of the University. The purpose of the fellowship is that of the Knight Prize, which is offered annually in the University, to encourage the study of psychological factors in the causation and cure of mental disturbances.

The following appointments have been made: Mr. F. G. G. A. Marraine to be assistant-lecturer in mathematics; Mr. R. J. Cornish to be assistant-lecturer in engineering; Mr. C. J. Polson to be demonstrator in pathology.

THE new buildings of the Swansea University College, which include the engineering laboratories referred to in these columns last week (October 31, p. 662) were opened by Lord Eustace Percy, president of the Board of Education, on October 31. The principal of the College, Dr. T. Franklin Sibly, referred in his opening remarks to the fact that all the students are now concentrated at Singleton, whereas previously many had to work at the Technical College, Mount Pleasant. Lord Eustace Percy said the opening of the new buildings marked "an attempt by the

university colleges to see that the system of higher education served the great industries of the country, so that skilled recruits could be drawn from the whole-time system of higher education, rather than that the industries should have to fall back on part-time technical training." The new engineering laboratories are provided with up-to-date electrical equipment including compound motors, alternators, rotary converters, an oscillograph outfit, certified standards of electromotive force and resistance, and so on. The courses in electrical engineering aim at giving a good general knowledge of the subject with a bias towards power generation, transmission and distribution.

New engineering laboratories at the Derby Technical College were opened on Friday, October 30, by the Hon Sir Charles A. Parsons. For many years past the work of the College has been hampered by the inadequacy of its building. As an extension on the original site is not feasible, new buildings have been provided a short distance away. They include laboratories for mechanics and heat, for more advanced work in applied mechanics and for heat engines respectively, as well as an engineering workshop. The rooms vacated in the main building enable additional provision to be made for physics, electrical engineering and metallurgy. Valuable gifts of plant have been received from local manufacturers, and local firms have assisted in the erection of the machines. In particular, Messrs. Rolls-Royce, Ltd., have presented and fitted up completely a motor-car engine with a Heenan and Froud brake, while the Derby Gas Co. have presented a Crossley gas engine coupled to a dynamo. Sir Charles Parsons referred to the remarkable progress of engineering during the last half-century, and to the consequent change which had taken place in the education necessary for engineering students. He emphasised the importance of practical as well as theoretical training, and offered his congratulations on the completion of the new laboratories.

UNIVERSITY COLLEGE, London, has issued an appeal for 500,000*l.* in order to mark the centenary, in 1927, of the laying of the foundation stone of what was then known as the University of London. The name was changed later to University College, and the College was incorporated in the University of London in 1907, so the celebrations will be of unusual interest as marking the beginning of the second century of university education in London. The activities of University College have increased widely, particularly during the past twenty-five years, and the appeal now sent out is for funds for building developments, equipment and endowment. Among the items set out are a Great Hall, completion of the Gower Street front, electrical equipment for the new chemical laboratories, new buildings for the Departments of Zoology and Comparative Anatomy and Chemical Engineering, the reconstruction of the Departments of Applied Mathematics, Physics, Engineering, and of the General Library, while the Science Library is not yet completed. With regard to the endowment of teaching, the aim is to establish funds which will enable the College to offer the remuneration necessary to attract and retain a teaching and research staff of the highest rank. At present, the chairs of geography and engineering (civil and mechanical), among others, are without endowment, while the chairs of applied mathematics and mechanics, mathematics, botany, geology, physics and zoology are not in receipt of adequate support. Half the sum which it is hoped to raise will be devoted to endowment, thereby releasing general funds for other purposes. The appeal is under the patronage of Prince Arthur of Connaught; the treasurer is Sir Robert Kindersley, to whom donations should be sent, at University College, and the secretary is Dr. W. Seton.

Early Science at Oxford.

November 8, 1687. Mr. President shewed the Society the edition of *Aristarchus de magnitudinibus & distantijs Solis & Lunæ*, in Greek and Latin, the care of which he had taken at the desire of this Society. Then Dr. Smith gave an account of what mathematical manuscripts were in Magdalen College Library.

November 9, 1683. Dr. Plot was pleased to shew some leaves, acorns, and a large branch, of an English Cork-tree, which grows at Abingdon in Cambridgeshire, after which, ye Doctor showed a peice of white marble, which he had stained to a dusky black; ye colour entering $\frac{1}{4}$ of an inch or more. He then acquainted ye Company, with ye severall methods, ye smiths use at Wolverhampton, in Staffordshire, in hardening, and softening, their Iron.

They harden Iron with burnt hoofs, horn, fountain salt, bay-salt, sublimat, urine, and old burnt leather, and tartar, all mix't together, and reduced into a powder, in which they roll ye Iron red hot, to which it will stick, and so put it into ye fire again to harden; which it does only on ye outside to ye thickness of a shilling. They have two sorts of hardening in this town, tough-hardening, and brittle-hardening, which they use according as ye Instruments they make, require. Dr. Plot was told by another, as a secret, that ye toughest hardening was made by ye juice of nettles, mans urin, and linseed oyl, and ye highest by quenching Iron red hot in ye juice of mous eare.

Dr. Smith has undertaken to procure a new Chart, made by a gentleman, (whom ye Doctor knew at Constantinople,) who has lately travelled from Muscovy to China; by this chart it appears, that those two countries are not so far distant from one another, as our maps commonly make them.

November 10, 1685. A Caconut was presented ye Society by Dr. Plot, which, being opened, yielded ye milk, ye white kernell encompassed by a hard shell, (of which drinking cups are frequently made) and a loose cortex over that an inch and $\frac{1}{2}$ thick, of which linen is frequently made.

Mr. Bobart shewed a very curious collection of leaves and seeds of plants lately brought from St. Christopher's, of which he promises a more full account in writing.

November 11, 1684. An account of the preparation of Tartarum Vitriolatum was communicated by Dr. Plot, and also an account of ye weather here at Oxford the last moneth.

A letter from Mr. Cole, dated from Minehead, October ult: 1684, was read; it contain'd more of his observations concerning ye dying shellfish.

Mr. Charles Leigh communicated severall curiosities observ'd by him in Lancashire; particularly of Barnacles, which he takes to be a Shellfish, not a bird; of Caterpillars, concerning which he is of opinion, that ye old ones are killed by the younger; of worms in apple-kernells almost as large as ye kernells, which he urges as an argument against *omnia ex ovo*; unless perhaps ye egg rises with ye juice of ye tree; of a peice of chalk of ye shape and bigness of a muscleshell, taken out of ye bladder of a hog. Of waters impregnated with Latrôn. Of a Water in that Countrey, which, by falling on wood, turns into a substance which rings like a bell. Of a water from a white marl 2 ounces in a quart lighter then common water usually is.

Mr. Vice Chancellor communicated to ye Society severall stones, all of a cubical form, but of several sizes; all *pyrites aurei* found plentifully at St. Davids in Pembroke-shire: whereof Dr. Plot said that they were the true *Ludus* of Paracelsus.

Societies and Academies.

MANCHESTER.

Literary and Philosophical Society, October 13.—W. W. Haldane Gee: (1) John Dalton's spectacles. The vision of John Dalton was very abnormal. He was colour-blind and also short-sighted. We have now definite knowledge of the extent of this defect, for the Misses Taylor of Manchester have given the Society a pair of Dalton's spectacles. The frames are of blued-steel, hand-made, and were originally furnished with swinging arms to fit round the ears, as seen in the portraits of Dalton. The lenses are of the periscopic concave type with a power of 5 diopters. The use of such strong lenses proves that Dalton was very short-sighted, and he would be obliged to wear his spectacles to see objects at a distance, though it is very possible he would be able to read the smallest print at a distance of 8 or 9 inches without any glasses. (2) John Dalton's pupil's note-book. The Misses Taylor of Manchester have also presented on loan to the Society a note-book used by a relative, who was a pupil of John Dalton. It contains notes relating to mathematics, natural philosophy, and meteorology. Two of the entries under the last-named head are of general interest in connexion with the weather. It is noted that "the mean annual temperature at Manchester for 47 years is 48.8," also that the "rain in the first six months of the year is to that of the last six months as 2 to 3." The Stonyhurst College Observatory records give for the mean annual temperature for the last 77 years 47° Fahrenheit, which does not differ much from that noted by Dalton's pupil, for Manchester. The rainfall there for the last six months of the year divided by that for the first six months gives the number 1.491, a most remarkable verification of Dalton's corresponding number of 1.50.—W. L. Bragg: The sizes of atoms. The atoms cannot be regarded as incompressible bodies occupying a definite volume. The limit to the approach of two atoms appears to be set by the action of a repulsion between them, which rapidly increases as the distance between the atomic centres lessens. This field sets in so rapidly, however, that we may form a picture of the packing together of atoms by supposing them to be spheres nearly constant in size, but slightly elastic and compressible. This picture helps to explain the form of many compounds, though it breaks down entirely in other cases and its limitations must be carefully considered. A chief constituent of many inorganic compounds is oxygen. The repulsive force between oxygen atoms assumes a large value when their centres are 2.7 Å. (2.7×10^{-8} cm.) apart. The size of other atoms is in general much less, so that in many inorganic crystals the scale and shape of the whole structure are determined chiefly by the oxygens. A number of models may be made to illustrate this peculiar importance of oxygen. In some of them the structure may be regarded as a closely packed assemblage of oxygen atoms with other atoms in the chinks between them acting as a cement to bind the whole together.—J. M. Nuttall and E. J. Williams: β -rays associated with X-rays. The β -rays associated with homogeneous X-rays have been studied by the Wilson cloud expansion method, the required wave-length being sorted out by reflection from a crystal. The relative numbers of recoil and photo-electron tracks (in various gases) have been determined for a series of wave-lengths of primary X-rays. Several hundred

tracks have been counted and the numbers are in general agreement with the quantum theory of X-ray scattering as advanced by Compton. The results show that the fraction of scattered X-ray quanta which give sufficient energy to the recoil electron to enable it to leave the atom and produce a track, increases with decreasing wave-length of primary X-rays and approaches unity.

PARIS.

Academy of Sciences, September 7.—Jacques Chokhatte: A general formula in the theory of polynomials of Tchebycheff and its applications.—F. Baldet: The presence of the red cyanogen spectrum in Daniel's comet (1907d). A photograph of the spectrum of Daniel's comet, taken in August 1908, shows a red band not previously noted by any observers of this comet. By comparison with the carbon arc spectrum, taken with the same prism objective, it has been found that the comet band coincides with a band in the carbon spectrum, not only in position, but also in the relative intensities of corresponding points. These bands have been identified by Fowler and Shaw with the red spectrum of cyanogen.—V. Nechville: A relation between the mean proper motion and stellar magnitude from the first negatives of Henry.—A. Duboin: The application to chromium of a general method of synthesis of fluorides and silicates. The oxide or fluoride of chromium is added to fused acid potassium fluoride, the mass raised to a red heat and silica added. After slow cooling and extraction with water, the silica is found well crystallised as tridymite, the chromium as the crystallised double fluoride, $3\text{KF} \cdot \text{CrF}_3$.—Viret: The rodent fauna of Saint-Gérard-le-Puy (Allier).—C. T. Popeso: Comparative sleep and awakening of the primordial leaves in grafted and non-grafted beans.—E. Ducloux and Mlle. G. Cordier: The pancreatic extract of *Acanthias vulgaris*; its action compared with that of ox insulin.

September 14.—André Blondel: A modulometer arrangement for the control of radiotelegraphic emissions.—Alfred Rosenblatt: Algebraic varieties of three dimensions of which the types satisfy the inequality $P_3 \leq 3(p_3 - p_4 - 3)$.—Rolf Nevanlinna: Some properties of meromorphic functions in a given angle.—Michel Samsoen: An anomaly of the expansion of glass. The case of boric anhydride. At about 250° C., the coefficient of expansion of boric acid undergoes a sudden increase, from 15×10^{-6} to 200×10^{-6} . This result was obtained by two different experimental methods.—L. Daniel and E. Potel: Grafts of the sweet almond on roots of belladonna. In the graft there is a reduction in the amounts of cellulose and of atropine.—Alfred Labriet and Raoul Husson: The principles of vocal education by the realisation of vocal agreement.

September 21.—P. J. Myrberg: The simultaneous reduction of two quadratic forms.—A. Kovanko: A class of points of non-uniform convergence of series of functions.—Mandelbrojt: The best approximation of analytical functions and their singular points.—B. Galerkin: A plate, in the form of a rectangular isosceles triangle, placed on its contour, submitted to the action of forces acting normally to its surface on the axis of symmetry.—R. de Malle-mann: The diffusion of light by active and inactive molecules. A criticism of some conclusions of Gans relative to the diffusion of light by active molecules.—René Wurmser: The activity of various radiations in photosynthesis.—Const. A. Kténas: The eruption of the volcano of Santorin.—A. Poli-

card and A. Paillot. Study of silk secretion with the aid of filtered ultra-violet rays (Wood's light). Examined in Wood's light, certain parts of the silk-worm, especially the blood, show a brilliant yellow fluorescence. The method is of some practical interest, as the appearance of the silk-worm in filtered ultra-violet light is modified by bad nutrition or by disease.—R. Legendre: A tortoise (*Sphargis coriacea*) caught in the bay of Concarneau.—J. Roger d'Ansan. Ocular gymnastics applied to the treatment of amblyopia ex-anopsia and the strabism derived from it.—Charles Lebailly. The reappearance of foci of foot and mouth disease and the continuity of the virus in Nature. Experiments on six farms were carried out with the view of testing the theory that the virus was carried in cavities in the hoofs of cattle recovered from the disease. Sixty-two cured cattle in all were placed in contact with 450 fresh beasts, but the results were all negative, no return of the disease taking place. The author considers that these experiments definitely disprove the theory of virus latent in the feet of cattle after recovery from foot and mouth disease.

ROME.

Royal Academy of the Lincei: Communications received during the vacation.—Leonida Tonelli: The absolute convergence of Fourier's series.—F. Zambonini and R. G. Levi. Investigations on the isomorphism of molybdates of the rare earth metals with those of calcium, strontium, barium and lead. In view of the fact that a compound such as CaMoO_4 forms mixed crystals with $\text{Ce}_2(\text{MoO}_4)_3$, it is proposed to examine by roentgenographic means the structure of such crystals.—F. Zambonini and V. Caglioti. Neodymium thallous sulphates. The double sulphates having the formulae $\text{Nd}_2(\text{SO}_4)_3 \cdot 4 \cdot 5 \text{Ti}_2\text{SO}_4 \cdot \text{Nd}_2(\text{SO}_4)_3 \cdot \text{Ti}_2\text{SO}_4 \cdot 8\text{H}_2\text{O}$ and $\text{Nd}_2(\text{SO}_4)_3 \cdot \text{Ti}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$ are described.—L. A. Herrera. Additional figures illustrating various communications. The figures deal with the blastomere of the trout, the imitation of cell-division by means of collodion and ultramarine, and karyokinesis figures in crystals of metaformaldehyde.—Giuseppe Levi. Autonomous growth, by amoeboid movement, of fragments of neurites separated from the trophic centre.—Gabriele Mammanna. A new method of studying linear differential equations.—B. Marzetti. A deviation from Poiseuille's law. The non-linear relationship between the velocity of flow of rubber from a tube or orifice and the pressure to which it is subjected is considered.—Luigi Rolla and Giorgio Piccardi. Chemical statics of electronic phenomena.—G. Bargellini. α -Diphenylcoumarins.—Lorenzo Fernandes. Isomorphism between quadrivalent uranium and zirconium.—A. Ferrari. The crystal structure of lead dioxide examined by means of X-rays. Crystalline lead dioxide has a tetragonal structure of the rutile type, the elementary cell containing two molecules of the dioxide.—G. Scagliarini and G. Tartarini. Products of the oxidation of complex sulphites of trivalent cobalt.—Adriana Stolfi. The behaviour of lead containing RaG in the formation of formaldehyde according to Thunberg's theory.—Francesco Vercelli. Theory of the propagation of radiant energy through water.—E. Onorato. The epsomite of the north-west mine of Idria.—G. Checchia-Rispoli. Cainozoic echinoids of Cirenaiica collected by Camillo Crema.—G. Campanile. Contribution to the study of the systematics of the genus *Cuscuta* (section "Cistogrammica" Englm.).—Alberto Piróvano. Observations on electric mutations and on the process of ionolysis in gametes.

Official Publications Received.

- Bulletin of the Terrestrial Electric Observatory of Fernando Sanford, Palo Alto, California. Vol. 2. Summary of Observations on Earth Potential Air Potential Gradients and Earth Currents, September 1923–December 1924. Pp. 85 (Palo Alto, Calif.).
- Field Museum of Natural History. Publication 234, Zoological Series, Vol. 14, No. 3: The Brains of the South American Marsupialia Ctenolestes and Orolastes. By Jeannette Brown Obenchain. Pp. 178–282+plates, 24–38. Publication 235, Botanical Series, Vol. 4, No. 3: The Taxonomy of *Possor. Ivy*, with a Note on the Origin of the Generic Name. By James B. McNair. Pp. 52–76+plates 14–34. Publication 237, Report Series, Vol. 6, No. 4. Annual Report of the Director to the Board of Trustees for the Year 1924. Pp. 265–383+plates 47–62. Publication 230, Museum Technique Series, No. 2. New Uses of Celluloid and similar Material in Taxidermy. By Leon L. Walters. Pp. 20+7 plates (Chicago).
- Smithsonian Institution. United States National Museum. Bulletin 180. Life Histories of North American Wild Fowl, Order Anseres (part). By Arthur Cleveland Bent. Pp. x+376+80 plates (Washington. Government Printing Office). 40 cents.
- Department of the Interior. United States Geological Survey. Water-Supply Paper 822: Surface Water Supply of the United States, 1921. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. iv+72+2 plates. 10 cents. Water-Supply Paper 826: Surface Water Supply of the United States, 1921. Part 6: Missouri River Basin. Pp. vii+231+2 plates. 80 cents. Water-Supply Paper 584: Surface Water Supply of the United States, 1921. Part 13: North Pacific Slope Drainage Basins. C. Lower Columbia River Basin and Pacific Slope Drainage Basins in Oregon. Pp. vi+171+2 plates. 20 cents. Water-Supply Paper 614: Surface Water Supply of the United States, 1922. Part 4: Lawrence River Basin. Pp. iv+140+2 plates. n.p. Water-Supply Paper 548: Surface Water Supply of the United States, 1922. Part 8: Western Gulf of Mexico Basins. Pp. iv+124+2 plates. 15 cents. (Washington Government Printing Office).
- Smithsonian Institution. Bureau of American Ethnology. Bulletin 78. Handbook of the Indians of California. By A. L. Kroeber. Pp. xviii+995+83 plates (Washington: Government Printing Office).
- Thirty-Ninth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1917–1918, with Accompanying Paper, The Ojaga Tribe. Rite of Vigil, by Francis La Flesche. Pp. 686+17 plates (Washington: Government Printing Office).
- Department of Commerce. Bureau of Standards. Miscellaneous Publication of the Bureau of Standards, No. 56. Tables and Graphs for Facilitating the Computation of Spectral Energy Distribution by Planck's Formula. By M. Katherine Frehafer and Chester L. Snow. Consisting of 7 sheets (6 charts). Text (sheet 1); Graphs: 1000 to 5000° K. (sheets 2, 3, 4); Charts 1, 2, 3, 5000 to 8000° K. (sheet 5, chart 4); 8000 to 24000° K. (sheet 6, chart 5); Tables (sheet 7) (Washington Government Printing Office). 35 cents.
- Transactions of the Royal Society of Edinburgh. Vol. 64, Part 2, No. 2. Contributions to the Study of the Old Red Sandstone Flora of Scotland. 1. On Plant-Remains from the Fish-Beds of Cronraty. 2. On a Sporangium-bearing Branch-Sytem from the Stromness Bed. By Dr W. H. Long. Pp. 258+270+4 plates. (Edinburgh: R. Grant and Son, London: Williams and Norgate, Ltd.) 5s.
- Statens Meteorologiska Hydrografiska Anstalt. Årsbok, 4, 1922. Pp. vii+183 (Stockholm) 10 kr.
- Abisko Naturvetenskapliga Station. Observations meteorologiques à Abisko en 1918. Meteorologiska iakttagelser i Abisko år 1918. Ridgöepar Sammanställda av Bruno Rolf. Pp. iii+70 (Stockholm).
- Meddelanden från Statens Meteorologiska-Hydrografiska Anstalt. Band 2, No. 4. Vattenståndet vid rikets kustar åren 1887–1921. A. Polke Bergsten. Pp. iii+85. 3 kr. Band 2, No. 5. Undersökningar över de Elementen des Nebels and der Wolken. Von Hilding Kohler. Pp. 78+8 Tafeln. 4 50 kr. Band 3, No. 2. De Svenska väntandagens Återförhållanden. Del 1. Luleå m. fl. av Gustaf Wersén. Pp. 14+1 karta. 1 50 kr. Band 3, No. 3. Synoptiska väderlekskarter i navigations-Tjänst. Av F. Lindholm. Pp. ii+16. 1 kr. Band 3, No. 4. Kartor över den årliga nederbörden fort elning på Skandinaviska halvön. Av H. W. von Ahlmann. Pp. 6+1 karta. 1 50 kr. (Stockholm).

Diary of Societies.

SATURDAY, NOVEMBER 7

- ROYAL SOCIETY OF MEDICINE (Otolary Section), at 11.30 a.m.—A. R. Thesdale. The Otolith Reaction.
GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—G. W. Young. The Yellow-stone Park, U.S.A. (Lecture).

MONDAY, NOVEMBER 9

- ROYAL IRISH ACADEMY, at 4.15.
ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. J. W. Gregory. (a) Scottish Drumlins, (b) The Scottish Kames and their Evidence on the Glaciation of Scotland.—J. M. Wordsie. Notes on the Geology of Jan Mayen.—Dr. G. W. Tyrrell. The Petrography of Jan Mayen.—Dr. M. A. Peacock. The Geology of Videy, S.W. Iceland. A Record of Igneous Action in Glacial Times.
INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 8.—E. B. Ball. Some Engineering Features in connection with Irrigation in South Africa (Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. S. Rutter and others. Discussion on Modern Developments of Telephones Cables.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—P. Donath. Dielectric Problems in High-Voltage Cables.
INSTITUTE OF METALS (Scottish Local Section) (at Institution of Engineers and Shipbuilders in Scotland, 40 Elmbank Crescent, Glasgow), at 7.30.—Dr. J. A. Cranston. Binding Forces between Atoms.

SURVEYORS INSTITUTION, at 5—J. D. Wallis. Presidential Address
MEDICAL SOCIETY OF LONDON, at 8.30—Dr. R. Hutchison and others.
 Discussion on *Obscure Pyrexia in Childhood*
ROYAL GEOGRAPHICAL SOCIETY (at Eolian Hall), at 8.30—Dr. Knud Rasmussen. From Greenland to the Pacific.
CAMBRIDGE PHILOSOPHICAL SOCIETY (in Botany School, Cambridge), at 8.45—Prof. B. M. Jones. Wings.
BIOCHEMICAL SOCIETY (at King's College)—J. A. Hewitt and H. G. Reeves. (a) Trimerism of Glyceric Aldehyde. (b) Constitution of Glyceric Aldehyde.—Prof. C. Loati Evans. Lactic Acid Formation in Plain Muscle.—Dr. Elizabeth S. Semmens. The Hydrolysis of Starch in the Guard Cells of the Stomata of a Monocotyledon.—J. Gordon, J. W. McLeod, and H. Wheatley. The Importance for the Bacteriologist of Differentiating between the Amino-acids which Favour and those which Inhibit Bacterial Growth.—J. R. Marrack and G. D. Thacker. The Influence of Ionic Strength on the Equilibrium of Calcium Ion in Bicarbonate Solutions.

TUESDAY, NOVEMBER 10.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. Shadwell. Medicine in Ancient Egypt, Assyria, and Palestine (FitzPatrick Lectures, I).
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 8.30—Ing. L. Steinschneider. The Principles of the High Vacuum Distillation of Mineral Oils.—Dr. W. R. Ormandy and E. C. Craven. (a) The Determination of Unsaturation in Petroleum Spirit; (b) The Determination of Molecular Weight of Petrol.
INSTITUTION OF AERONAUTICAL ENGINEERS (at Junior Institution of Engineers), at 8.30—M. L. Brannon. Practical Flying.
INSTITUTE OF MARINE ENGINEERS, at 8.30.—E. F. Spanner. Construction of Ship. A Proposed Method of Minimizing Risk due to Collision.
INSTITUTE OF TRANSPORT (Midland Graduate Centre) (at Imperial Hotel, Birmingham), at 8.30.—A. Jackson. Passenger Fare Charges on Urban Tramway Services.
INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—S. D. Jones. Chairman's Address.
ROYAL PHOTOGRAPHIC SOCIETY (Scientific and Technical Group), at 7.—T. Thorne Baker and G. E. Pearce. Modern X-Ray Installations and their Work.
INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—Prof. M. Maclean. Chairman's Address.
PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, at 8.—Lt.-Col. Sir David Prain. Some Useful Plants of India (Lecture).
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—J. P. T. Burchell. The "Skull Mound" Industry of Denmark as represented at Lower Haldston, Kent.

WEDNESDAY, NOVEMBER 11.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. H. Gilford. The Prevention of Cancer and Allie Neoplasms.
ROYAL METEOROLOGICAL SOCIETY, at 5.—Dr. C. G. Abbot. Measuring the Sun's Rays (Lecture).
ROYAL COLLEGE OF HUMANS OF ENGLAND, at 5.—J. Sheiien. Gastrojejunostomy (Bradshaw Lecture).
INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—Sir E. Owen Williams. The Relative Economy of Different Classes of Reinforced Concrete Work.
INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at University, Birmingham), at 7.—W. R. Barclay. The Development of Alloy of Nickel and Chromium for High Temperature Work and Electrical Resistance Heating.
ROYAL SOCIETY OF ARTS, at 8.30.—Sir Cecil Harcourt-Smith. The Modern Note in Industrial Art (Trevelyan Wood Lecture).
ECONOMICS EDUCATION SOCIETY (at Royal Society), at 8.30.—Rev. J. C. Pingle. The Nervous Labour Colony in Belgium.
INSTITUTION OF CIVIL ENGINEERS.

THURSDAY, NOVEMBER 12

ROYAL SOCIETY, at 4.30.—Sir William Bragg and R. E. Gibbs. The Structure of a and β Quartz.—Lord Raveleigh. The Light of the Night Sky: its Intensity Variations when analysed by Colour Filters.—Prof. W. A. Bone and G. W. Andrews. Studies upon Catalytic Combustion: Part I.—Prof. O. W. Richardson and F. C. Chalklin. The Exentation of Soft X-Rays.—R. Campbell Thompson. On the Chemistry of the Ancient Assyrians.—J. E. Lennard-Jones. On the Forces between Atoms and Ions.—To be read in title only.—F. G. Mann and Sir William Pope. β β β Triaminotriethylamine and its Complex Metallic Derivatives.—K. R. Ramanathan. The Structure of Molecules in relation to their Optical Anisotropy. Part II.—Dr. E. V. Appleton and M. A. F. Barnett. On some Direct Evidence for Downward Atmospheric Reflection of Electric Rays.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Annual General Meeting.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. Shadwell. Medicine in Ancient Egypt, Assyria, and Palestine (FitzPatrick Lectures, II).
ROYAL AERONAUTICAL SOCIETY, at 5.30.—H. B. Howard. Some Problems in Aeroplane Structural Design.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—M. Yearsley. The Development of Speech in the Normal Child.
SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.—Dr. E. Vanstone. The Role of Phosphorus in Agriculture.
INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—I. Selar. A Comparison of Electrical Wiring Installations and Analysis of their Costs.
INSTITUTE OF METALS (London Local Section) (at Royal School of Mines), at 7.30.—Dr. R. S. Hutton and Dr. O. F. Hulson. Science and Industry: Some Impressions from the Early Experiences of the British Non-Ferrous Metals Association.
OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—S. A. Emerson. Some Recent Improvements in Modern Ophthalmic Lenses.—W. Swaine. Relation of Visual Acuity and Accommodation to Ametropia.

—Irregular Astigmatism of the Eye.—E. F. Fincham. Effect of Size of Pupil, H. H. Emsley. Effect of Corroding Lenses.—Exhibition and Description of the Zeiss Refraction Meter by J. W. Atha and Co.
INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre) (at Trinity College, Dublin), at 7.45.—G. G. Sutcliffe. Underground Telephone Construction.
INSTITUTION OF CHEMICAL ENGINEERS (at Institution of Mechanical Engineers), at 8.—Hon. H. Fletcher Moulton and others. Discussion on Scientific Research Workers and Industry.
INSTITUTION OF MECHANICAL ENGINEERS (South Wales Branch)—Eng. Lieut.-Colonel W. H. Reynolds. Chairman's Address.
OIL AND COLOUR CHEMISTS' ASSOCIATION.
INSTITUTION OF THE RUBBER INDUSTRY (Manchester Section)—Short Papers.

FRIDAY, NOVEMBER 13

ROYAL ASTRONOMICAL SOCIETY, at 5.—
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—T. G. Hodgkinson. Valve Maintained Tuning Forks without Condensers.—R. G. Edwards and B. Worwick. The Viscosity of Ammonia Gas.—Dr. C. Chree. The Times of Sudden Commencements (S.C.'s) of Magnetic Storms: Observations and Theory.—Demonstration of the Kinetic Properties of a Gas Jet by Dr. J. S. G. Thomas.
MALACOLOGICAL SOCIETY OF LONDON (at Luncheon Society), at 6.—W. A. Lindholm. On a Neglected Work containing Typifications of Molluscan and Brachiopod Genera.—E. Ashby. The Aranthoid Chitons of New Zealand with Descriptions and Figures, including several New Species and Photographs of Previously Unfigured Types.—A. W. B. Powell. Description of Two New Gastropods from Whangaroa, New Zealand.—A. S. Kennard and B. B. Woodward. Nomenclatorial Notes relative to British Non-Marine Mollusca. IV.—Rev. E. G. Alderson. The *Amphidaria swainsoni* of Philipp, Hanley and Reeve.—Exhibition of Illustrations and Photographs, taken from the Type Specimen in the Senckenberg Museum, of *Palaemon mirabilis* Milne, by B. B. Woodward, and Specimens of Shells and Radula illustrating a New Molluscan Family, and Genera, by J. R. Le B. Tomlin and Lt.-Col. A. J. Pele.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—Lt.-Col. K. Edgcombe. Some Controversial Problems.
JUNIOR INSTITUTION OF ENGINEERS, at 7.—Annual General Meeting.
INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—L. B. Pfeil. Effect of Crystal Size on the Mechanical Properties of Metals.
INSTITUTION OF ENGINEERS (Infection) (at Royal Society of Arts), at 7.30.—Dr. W. H. Hatfield. Modern Developments in Steels resistant to Corrosion.
INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—S. Field. Recent Advances in Electro-Deposition.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section), at 7.30.—A. T. Abernethy. Wireless Transmission and Reception.
ROYAL SOCIETY OF MEDICINE (Ophthalmology and Surgery Sections), at 8.30.—Joint Discussion on Plastic Operations on the Face in the Region of the Eye.
INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch)—Sir John A. F. Apinall. Some Railway Notes Old and New (Thomas Hawkey Lecture).

SATURDAY, NOVEMBER 14

ASSOCIATION OF MINING ELECTRICAL ENGINEERS (North of England Branch) (at Newcastle-upon-Tyne), at 5.—J. A. B. Horsley. The Selection, Lay-out, and Maintenance of Electrical Equipments at Collieries.
INSTITUTE OF TRANSPORT (North-East Centre) (at Newcastle-upon-Tyne), at 5.—C. J. Allen. British Main Line Passenger Train Services.
PHYSIOLOGICAL SOCIETY (at Cardiff).

PUBLIC LECTURES.

SATURDAY, NOVEMBER 7

HORNIMAN MUSEUM (Forest Hill), at 8.30.—R. A. Smith. Aspects of Roman London. I.

MONDAY, NOVEMBER 9.

KING'S COLLEGE, at 5.30.—Dr. W. T. Gordon. Geology and Civilisation (Swiney Lectures). (Succeeding Lectures on November 13, 14, 20, 28, 27, 30, Dec. 4, 7, 11, 14, and 18.)

TUESDAY, NOVEMBER 10.

KING'S COLLEGE, at 5.30.—Miss Hilma D. Oakeley. The Philosophy of Aristotle. Theory of Mind and Soul.
SURVEYORS' INSTITUTION, at 5.45.—E. H. Shaughnessy. Post Office Wireless Stations.
GREENHALL COLLEGE (Bavinghall Street), at 6.—W. H. Wagstaff (Geometry). (Succeeding Lectures on November 11, 12, and 13.)

WEDNESDAY, NOVEMBER 11.

UNIVERSITY COLLEGE, at 5.30.—Prof. G. Elliot Smith and the late Dr. O. F. Sonntag. The Evolution of Man. (Succeeding Lectures on November 18, 25, December 2, 9, and 16.)

THURSDAY, NOVEMBER 12

BEDFORD COLLEGE FOR WOMEN, at 5.15.—C. C. Baker. Italian Painting: its Place in Art.
KING'S COLLEGE, at 5.30.—Sir Arthur Newsholme. The Community and Social Hygiene.
UNIVERSITY OF LEEDS, at 8.—Lt.-Col. W. R. Mansfield. New Light on Christopher Columbus.

SATURDAY, NOVEMBER 14

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. A. Smith. Aspects of Roman London. II.



SATURDAY, NOVEMBER 14, 1925.

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Technical Libraries.

THE formation of the Association of Special Libraries and Information Bureaux, which held its second annual Conference at Balliol College, Oxford, in September, is a welcome sign not only that the librarians of technical and other specialist libraries are realising the need of co-ordination and co-operation amongst themselves, but also that manufacturers in Great Britain are at last seeing the vital importance of research to industry. They are realising the urgent necessity, therefore, of having ready access to existing library resources and greater facilities for ascertaining what is being done from day to day throughout the world.

The pressure behind the movement came in the main from outside and not from within the library world. The absence of the research habit in Britain, in contrast with the position in Germany, became so painfully evident after a few months of the War that the Government had no option but to undertake a Scientific Intelligence Service, which though conducted primarily for military purposes, yet necessarily covered so wide a field that it included in its survey a great deal of what in normal times would form part of the civil work of the nation. Fortunately, the necessity for a continuance after the War of similar organised efforts towards a comprehensive scheme of scientific research was clearly recognised, and numerous industrial research associations were formed, under the ægis of the Department of Scientific and Industrial Research, to act as laboratories and as feeders of up-to-date information for the benefit of the subscribing manufacturers. It is a significant fact that it was due mainly to the initiative of one or two of these research associations that the first Conference of Special Libraries was held at Hoddesdon last year, and that this was followed by the formation of an Association and the much larger Conference at Oxford this year.

At a very liberal estimate, the number of scientific and technical libraries in Great Britain may be put at about a couple of hundred. This figure, though probably not one-third of the number of similar institutions in the United States, where the Special Library Association has been in existence for more than sixteen years, may not on paper appear an unreasonable one for British needs. But when consideration is given to the fact that certainly more than one-half of this number—and of these probably the largest and most representative—would be found in London and its immediate neighbourhood, and when the nature and relative efficiency of the various collections are taken into account, it will surely be felt that the fullest advantage is not being taken even of the undoubtedly great resources we already possess.

There is, or was until quite recently, an entire lack of co-operation between the different libraries, even amongst those covering the same or closely related fields. Each shut itself in a watertight compartment, selecting and arranging its books and the still more important periodical literature without reference to its neighbours, and with the view solely of suiting the needs of its own readers—usually the members of the private or semi-private institution to which the library belonged. This involved a great deal of unnecessary duplication and a needless waste of effort, some fields being more than adequately covered, whilst others were only poorly or even not at all represented. Well-known treatises and journals could be found repeated in a number of libraries within walking distance of each other, to the entire exclusion of less well known but not always less important literature. A few fruitless efforts at reform have been made from time to time, especially in the field of engineering, but so far nothing has been accomplished that can in any way compare, for example, with the establishment of the United Engineering Societies Library in New York.

A beginning is, however, now being made in Great Britain, and one interesting experiment calls for special notice, namely, the scheme whereby, under agreement with the Carnegie United Kingdom Trust, approved special libraries are being linked up with the Central Library for Students. Already under this scheme a number of libraries—those of the Royal Aeronautical Society, the Scottish Marine Biological Association, the Rowett Research Institute, and others—have agreed to lend their books and periodicals (other than exceptional rarities) to borrowers applying through the Central Library, the latter institution becoming responsible for their proper care and return. The benefits of such a scheme are obvious. The Central Library is relieved of the necessity of purchasing a number of books, etc., already to be found in these other libraries, whilst at the same time those who avail themselves of its services will be able to borrow many books and periodicals, including back numbers, not otherwise obtainable.

Co-operation of this character is especially valuable, and the establishment of central loan libraries will be of increasing importance in connexion with the small but highly specialised libraries that are being formed by industrial establishments, research associations, and so on. As these grow, the question of the provision of shelf space for their rapidly increasing literature will undoubtedly arise and will be solvable in one of two ways, either by diverting some of the not too extravagant funds now devoted to experimental research from the laboratory to the library, or by a periodical survey of the library shelves for the purpose of weeding out the less important material.

Happily for the future prospects of research, the latter alternative, granted proper co-operation between all concerned, is not only the most practicable, but also the most desirable one. It would usually be unnecessary for the type of library now being considered, concerned as it is mainly with the results of current research, to continue to keep on its shelves copies of old editions and long runs of patent literature, or of any but the most important periodicals. At the same time, no librarian would agree to discard such material unless he could be quite sure that it would be readily and immediately accessible in some other library, if and when required. A central library to which might be sent on loan conditions all literature that could ordinarily be dispensed with would meet his needs, and would in many other ways be an invaluable adjunct to all the special libraries of a district. The increasing specialisation, and the growing interdependence of the various branches of science, render it quite impossible for any but the very largest libraries to include all the literature that might at some time or another be wanted by its readers, and reliance on other sources is the only possible solution of the difficulty.

In this the greater public libraries of Great Britain may well play an important part. Many of the municipal authorities throughout the country—notably that of Manchester—are viewing with favour the formation as part of their library system of special technical sections having particular reference to the industrial interests of the district. It would not be a difficult matter to arrange that the special libraries of the neighbourhood should each restrict its selection of literature to that relating specifically to the subject with which it is mainly concerned, leaving the public library to provide for its needs in the way of general scientific works and the literature of neighbouring fields which might be required from time to time. The public library would also serve as the reservoir, of which we have spoken, for the less important material weeded out periodically from the specialist libraries to make room for current growth. By reciprocal loan arrangements, such material would always be available when required, and the public and specialist libraries would each be able to draw on the resources of the other in case of need. Any specialist library would thus have access to a far wider range of literature than it could possibly hope to provide for itself, and would at the same time, by the elimination of the necessity to provide works on subjects outside its immediate scope, be enabled to make its own collection more fully representative of its subject than would otherwise be the case. Consolidated catalogues kept up-to-date in each of the libraries concerned would be a necessary corollary.

In London, with its varied interests, a somewhat

different method might have to be introduced, and a separate loan library be formed as an auxiliary to the scientific libraries of the Metropolis, to which the rarely used volumes could be sent for the common use and benefit.

With greater co-operation between scientific institutions, we may expect to see an improvement in those indispensable tools of the research worker, abstracts and indexes of periodical literature. An enormous amount of unselfish work is being done in this field at the present moment, and unity of effort is being aimed at in more than one direction. The two leading chemical societies have since last year pooled their abstracting resources in the Bureau of Chemical Abstracts, and though two separate publications, differing in format, one for pure and one for industrial chemistry, are still being issued, it is understood that with next year the two publications will be combined into one. A much larger question arises when the actual number of journals abstracted or indexed is considered. Though we are still waiting for the second volume of the "World List of Scientific Periodicals," we shall not be far wrong in assuming that a considerable proportion of the current periodicals recorded in that invaluable work are not to be found in any British library. Dr. Chalmers Mitchell, at the Oxford Conference, made the bold suggestion that a central library should be established which should contain a copy of every current periodical issued throughout the world and publishing scientific and technical research, and keep it available for the use of indexers and abstractors for two years after publication. After that period the volumes would be distributed for permanent reference to other suitable libraries. Such a library would not be a lending library, but would be available only for abstractors and indexers from recognised organisations, and for the librarians of other libraries. A certain amount of cold water has been thrown on the proposal on the ground of the extensive nature of the work involved; but nothing is impossible unless we make it so.

Such are some of the many problems awaiting solution in the world of technical libraries, before these can render to the community that service which they alone can give, and, it may confidently be expected, will more and more be demanded of them. Improvements in the facilities provided and the growth of a healthy desire for knowledge of what others are doing in invention and research will proceed *pari passu*, for the two are mutually dependent and will stimulate each other. The newly formed Association of Special Libraries is supplying the necessary impetus. From the seriousness with which it is setting about its self-imposed task, there is distinct hope that one at least of the lessons taught by the War will not be forgotten

Ancient Assyrian Chemistry.

On the Chemistry of the Ancient Assyrians. By Dr. R. Campbell Thompson. Pp. 158+6 plates. (London: Luzac and Co., 1925.) 25s. net.

DR. THOMPSON'S brilliant monograph on ancient Assyrian chemistry is worthy of very careful study. To appreciate it fully one must be both an Assyriologist and a chemist, but even those who, like the present writer, have no knowledge of cuneiform, will delight in Dr. Thompson's skill in argument, lucidity of explanation, and quickness in perceiving the key to difficulties. His results and conclusions are of considerable importance, and, while one may not always agree with him entirely, he has certainly thrown a flood of light upon the chemical knowledge of one of the most talented nations of antiquity.

The texts concerned form part of the remains of the royal library of Ashurbanipal, now preserved in the British Museum. They describe in detail the processes of glass-making as practised by the Assyrians of the seventh century B.C., and give information not only on the composition of various kinds of glass but also on a variety of colouring matters used in the production of tinted glass. By subjecting these texts to a close and critical examination in the light of philology, checked at each step by appeal to chemistry and to known methods, ancient and modern, of glass-making, Dr. Thompson has succeeded in identifying a surprisingly large number of chemicals. It becomes evident, indeed, that chemistry of a practical and empirical nature must have been brought by the Assyrians to a level hitherto unsuspected.

Dr. Thompson points out that up to the present time the Assyrian words for minerals and stones have been much neglected, and that the custom has too commonly been to regard the large number of substances specified by the determinative for "stone" as (exclusively) "precious stones." He inclines to the view that "stone" in the scientific texts must have a much wider meaning; that it must, in fact, include mineral drugs and inorganic pigments. This suggestion, the fruitfulness of which is shown throughout the book, has a great deal to recommend it. Most important of all, perhaps, is the fact that in the related Semitic language of Arabia we find that the chemical writers habitually use the term *hajar* ("stone") for any inorganic chemical. Since the early Arabs undoubtedly derived many of their mineral-names, and possibly much of their empirical chemical knowledge, from Assyria, it is not incredible that this technical use of the word "stone" may have been handed down to them in the same way. Quite apart from this extraneous evidence, however, it is difficult for any one who follows Dr. Thompson's arguments to

disagree with his view that *abnu* (determinative of *stone*) must be allowed to bear a far more extensive interpretation than that hitherto given to it.

Consideration is next devoted to the solution of the problems presented by the glass-making texts. Here the author bases his procedure upon the principles involved in the technique of modern methods. The essentials in all glass-making are silica, an alkali, and lime or less probably lead. A decolorising agent, such as manganese dioxide, is usually added. That all these substances were used so far back as A.D. 79 is proved by an analysis of window-glass from Pompeii:—*silica*, 69; *soda*, 17; *lime*, 7; *alumina*, 3; *iron oxide*, 1 per cent.; *manganese and copper*, traces. Chemical analysis of ancient glasses has, moreover, revealed the nature of many of the colouring agents employed in the manufacture of tinted glass; thus Assyrian blue glass has been found to contain copper, and red glass cuprous oxide. Assyrian white glass contains tin oxide, while lead antimonate has been discovered in yellow.

From data of this kind, it becomes an easier task to identify the names of the principal constituents of Assyrian glass as given in the texts. *Uḫulu*, *immanakku*, and *namrutu* are the basic substances. The first, *uḫulu*, has long been recognised as “alkali,” and Dr. Thompson is able to show that *immanakku* probably represents a pure quartz sand. Since the word for lead (*anaku*) does not occur in any of the glass-texts, it is reasonable to assume that *namrutu* signifies a form of lime or limestone, and the author brings evidence to show that it is probably chalk. With the three main ingredients definitely settled, attention can be devoted to the rest, and it is here that Dr. Thompson's ingenuity and erudition achieve their most brilliant successes. It is here, too, that the chemist and philologist will find much to fascinate them—the first in the astonishing chemical knowledge which the texts imply, and the second in the discovery that many familiar names of minerals are of Assyrian origin.

To the chemist, one of the most interesting of the recipes is that which appears to describe a prototype of the Purple of Cassius. Dr. Thompson thinks that the aim of the operation described in this recipe is to produce an artificial pink or red coral. The ingredients of the mixture are given as 7200 parts of a glass base, 32 parts of *tuskū* (oxide of tin?), 20 parts of *abarū* (which Dr. Thompson identifies with antimony), (?) parts of *mil'u* (a salt), and 1 part of gold. The proportion of gold here stated (0.014 per cent.) is of the usual order of magnitude in the preparation of ruby glass.

The recipe just mentioned is of much interest to the philologist also, since it necessitates the identification of no less than three constituents. One of them is the

substance which is called *abarū*. Any one who has studied ancient chemical texts knows how tantalising this word is. Dr. Thompson, following Ibn Baithar, identifies the Arabic *al-abar* with antimony, and compares *al-abar* with the Assyrian *abarū*. But *abar* in Arabic chemical texts seems to have a good many different meanings, not the least common being that in which it is used for the elixir. Thus in a chemical poem attributed to Khālid ibn Yazīd the elixir is described as “that which the people of this Art (alchemy) call *Abar*,” and the same name is elsewhere applied by Khālid to the “tincture” of metals. Abu'l-Qāsim al-'Irāqī (XIIIth cent.), however, distinctly says that *abar* is another name for lead (in his book *Al-Aqālim al-Sab'a*). According to the *Mustā'inī*, again, *abar* is tin. I am inclined to think that the most satisfactory meaning to ascribe to *abar* is “the metal extracted from collyrium,” in which case it would mean either lead or antimony, between which early chemists could scarcely distinguish with accuracy. *Tuskū* Dr. Thompson tentatively identifies with oxide of tin, since (a) it signifies a substance used to make white (cloudy) glass, and (b) oxide of tin has actually been discovered in Assyrian glass. He also makes the interesting suggestion that in *tuskū* we may have the origin of the word *tutia*. *Mil'u* is identified temporarily with saltpetre, but it is worth pointing out that *milh* (salt) in Arabic chemical texts apparently never has this meaning, and that there is no reliable evidence that saltpetre was recognised as a distinct substance before the tenth century at earliest.

Other names of interest are *guhlu* (eye-paint), whence the Arabic *kuhl* and our *alcohol*; *šindu arqu* (yellow paint), whence *sandarach*; *šadanu*, whence the Arabic *shādāna*, hæmatite. The Arabic *urjuwān* (purple), a title often given to the Elixir and used, too, in the description of the colours of clothes (e.g. *Mufaḍḍaliyāt*, Sir C. Lyall's edition, Oxford, 1918, ii. 249), is shown to go back to the Sumerian *argamanu*, red purple. *Sapphire* is traced back to the Assyrian *šipru*, and means “the scratching stone” (from *šapāru*, scratch), a name no doubt given to it on account of its great hardness (it is next to the diamond in Moh's scale). *Marcasite* apparently comes from *marhašz*, which probably means “pyrites.” Finally, it is thrilling to find a mineral called *kiballu*, and one hopes that it may be possible to show a connexion between this and cobalt, though for the present Dr. Thompson refrains!

The book is clearly printed from type-written stencils, is amply indexed, and includes the cuneiform texts, which are given on six plates at the end. It is earnestly to be hoped that Dr. Thompson will continue his researches upon Assyrian chemistry, and we shall look forward with eagerness to his next volume.

E. J. HOLMYARD.

The Colour Line.

The Menace of Colour: a Study of the Difficulties due to the Association of White and Coloured Races, with an Account of Measures proposed for their Solution, and Special Reference to White Colonisation in the Tropics. By Prof. J. W. Gregory. Pp. 264+4 plates. (London: Seeley, Service and Co., Ltd., 1925.) 12s. 6d. net.

HAPPILY there is as yet no sense of the colour line in Great Britain in the sinister interpretation of the term, except perhaps among a restricted few. We may have prevented by law a few coloured musicians from entering Britain; but that is trade unionism directed against foreigners in general; and only recently a coloured actor has received an ovation in the press, all the more hearty because of, and not despite, the fact that he was a member of a race which has not normally been admitted to an opportunity to excel in this field. Yet if any are in doubt of the fact that the relations of races, at different stages of culture, who live side by side in the same community constitute one of the grave problems of the future, Prof. Gregory's book may be commended to them as an antidote for short-sighted optimism.

In "The Menace of Colour" the author has surveyed the main facts bearing upon the difficulties which arise when a white and a coloured population coexist in one and the same community. He has summarised some of the more authoritative views which have been expressed upon the question, and he discusses the arguments for and against the various solutions which have been proposed. Most attention has been given to those countries of which he has first-hand knowledge—the United States, South Africa, and Australia. Of these, the first two are countries in which the conditions, even though obscured by controversy, seem to demand action most insistently of all, while in the last named, the policy of "white Australia," of which Prof. Gregory is known as a staunch supporter, has been no less heatedly debated, although the danger, if any, is not immediate.

The problem is not the same in all three cases. In the United States the negro has for long, at any rate ever since the war of 1861, been a grave social difficulty. Recently the antagonism between white and black has been accentuated by the wave of racial feeling which has overrun the country and finds expression in the popular phrase "100 per cent. American." This feeling underlies the immigration laws and is grounded in a belief in the essential superiority of certain races and the inferiority of cross-breeds. It may be noted in parenthesis that certain American anthropologists, while fully recognising the differences in races, have not

hesitated to maintain that the argument is fallacious. The feeling against mixed marriages extends beyond negro blood to Indian and all non-white; and certain States have not only forbidden such marriages, but have even established bureaux to investigate pedigrees of would-be entrants into the matrimonial state to the remotest ascertainable degree. They are also carrying on a vigorous propagandist campaign on so-called eugenic lines in their schools. It is scarcely necessary to repeat what has been said so often on the mixed-breed question, that the inferiority of the cross is difficult to prove in man, when the evidence, apart from biological analogies, is almost universally vitiated by the disturbing factor of adverse social conditions.

In South Africa the problem is in part social, but to a greater degree it is economic and political. The enormously rapid increase in the black population—a feature to be observed almost invariably when white rule over African peoples puts an end to the normal checks on increase such as warfare, infanticide, or other customs of like effect—has aggravated the difficulties of adapting the native to the political and economic system, while it threatens the continued existence of South Africa as predominantly a white-man country. It has become unable to absorb the numbers of colonists required for this end, since the lower grades of labour are practically closed to any but the coloured population.

The case of Australia is in some ways the most interesting. The policy of a "white Australia" is based upon a definite political and economic theory. It is a trade union policy on a large scale. Two criticisms have been levelled against it. On one hand, it is said that it can be only partially operative, as the northern area of Australia lies within the tropics and is not, therefore, a white man's country; and, on the other hand, that it delays the filling up and development of the country. The latter point, though perhaps of more moment than is often assumed, is still perhaps not so immediately urgent as to force a decision. The former is more serious. The question of the adaptability of the white man to tropical conditions is discussed very fully by Prof. Gregory, who inclines on the whole to answer it in the affirmative. It is open to doubt, however, now that tropical disease may almost be eliminated as a factor in non-survival, whether all European races can be regarded as equally fitted for permanent settlement in such countries. Even in most favourable conditions, such as are afforded in the higher lands of East Africa, there is some evidence of a deterioration in the second generation. On *a priori* grounds the suitability of the Nordic type may be doubted. More definite evidence based on observation is needed. Up to the present the data have been obscured by the incidence of disease.

The colour problem is undoubtedly grave and difficult. It is one which affects vitally the British Empire with its vast populations of non-European culture. The solution to which Prof. Gregory inclines is that of segregation, a segregation, be it noted, in the mass, but not a segregation which excludes intercourse of individuals. Yet he is led by the tendency of European peoples during the present century to withdraw from interference with extra-European populations, notably, for example, in China and India, to the view that ultimately the whites will be confined to Europe, North America, and Australia. While, however, every one who is interested in what is called, for convenience, the native question, is convinced that it would be to the advantage of primitive populations to be protected from unrestricted contact with European civilisation, the course of events seems likely to be against the possibility of isolation. Prof. Gregory notes in his introductory chapters that at the present rate of increase the population of the world would double in sixty years. Even if that rate of increase were not fully maintained, the time for which the vacant places of the earth can be allowed to remain fallow is limited. Post-War conditions have obscured the difficulties of food-supply which were becoming apparent in 1914. They are not likely to become less acute. Their mitigation must ultimately depend upon the development of agriculture in areas in which white labour is not practicable. It therefore becomes an urgent question whether segregation would allow for the training of the primitive peoples themselves, along lines in harmony with their mentality and culture, to take their share in the development of their country and thus avert the exploitation of these lands and their inhabitants, which otherwise seems inevitable.

Birth-Control.

Population. By A. M. Carr-Saunders. (The World's Manuals.) Pp. 112. (London: Oxford University Press, 1925.) 2s. 6d. net.

PROF. CARR-SAUNDERS has given us in this little book a most admirable discussion of the whole population question. He emphasises strongly the point that over-population is a relative term, the value of which depends entirely on the economic resources of the area under discussion. Thus, in the early Middle Ages, England with 6,000,000 inhabitants might have felt the pressure of population more severely than it does to-day with 40,000,000. He directs attention to the fact that all through human history voluntary checks on population have been practised; that in no known people was the regulation of increase left to the crude issue of natural selection. In a word, birth-control is

as old as the hills. It was the Christian Church which put a stop to the methods of birth-control formerly in vogue, namely, infanticide and abortion, owing to its insistence on the value of the individual. It is not to be wondered at, therefore, that that Father of the Church, Tertullian, regarded war, pestilence, and famine as divinely appointed agencies for keeping the increase of the human race within bounds.

Prof. Carr-Saunders shows that throughout the Middle Ages the populations of the various countries either remained stationary or increased slowly, and that in the apprenticeship system we find a means of postponing marriage until economic fitness for it was attained. The extraordinary increase in population which occurred during the nineteenth century is something quite exceptional in human history and was only rendered possible by the introduction of steam power and of mass production, which constitute what is misleadingly termed the "industrial revolution."

Prof. Carr-Saunders then discusses the outlook for the future and has nothing very encouraging to suggest. He admits that the population of Great Britain is increasing by 400,000 every year, and that emigration is no remedy, for the Dominions quite rightly will only accept our very best, and the total number of emigrants whom it is feasible to induce to leave our shores every year is only a small proportion of our annual increase in numbers. He derives some comfort from Prof. Bowley's prediction, based on our diminishing birth-rate, that in fifty years the population will cease to increase and that the births will then balance the deaths. This prediction is based on the doubtful assumption that the death-rate will remain as high as it is at present, but in the meantime we shall have added 15 to 20 millions to the population and emigrated about 5 millions! Prof. Carr-Saunders wisely points out that even the fall in birth-rate is differential; that the least fit have still the largest families, and that whereas formerly this higher birth-rate was balanced by a larger death-rate, humanitarian legislation has largely abolished this distinction, so that our population is being principally recruited from our worst stocks. He indulges in a tirade against "nationalism," which he regards as the fount of "wars," and predicts a peaceful break-up of the British Empire. We utterly and completely dissent from this view; and suggest that "humanity" is too wide and vague a concept to attract the loyalty of any man, that a man's duty is first to his family and then to his country, and that it is his duty to strive to make both economically strong.

The immediate need of Great Britain is a wider spread of the knowledge of the means of birth-control amongst the poorer classes, and when that is accomplished, a system of sterilisation enforced against all those who

produce children in the absence of the means to support them. These measures will meet with a great amount of opposition on the part of those of our population who are swayed by vague sentiment, but it is our conviction that they will ultimately be forced on us by economic pressure
E. W. M.

Guide-Books for the Naturalist.

- (1) *Salzburg*. Von Prof. Dr. Max Hoffer und Prof. Dr. Ludwig Lammermayr. (Junk's Natur-Führer.) Pp. xvi+406. (Berlin: W. Junk, 1925.) 6 gold marks.
- (2) *Sächsische Schweiz*. Von Dr. Walther Friese. (Junk's Natur-Führer.) Pp. x+354+3 Karten. (Berlin: W. Junk, 1925.) 6 gold marks.

THE geologist has long been indebted to the enterprise of German publishers for several excellent series of guide-books. Junk's "Natur-Führer," previous volumes of which have dealt with Tirol, the Riviera, Switzerland, South Bavaria, and Steiermark, are guides not only to the geology, but also to all subjects likely to interest the naturalist in the field. Attractively produced, and of convenient size, they contain numerous photographic illustrations, but maps have been omitted, owing to their prohibitive cost.

Primarily a guide-book of this nature must consist of a collection of local details arranged for ready reference. A mere collection of facts will, however, only bewilder the visitor unless he has sufficient general knowledge to collate them. It is, therefore, very necessary that a naturalist's guide-book should contain a few introductory chapters, generalising on such subjects as the physical geography, the geology, the botany, and the animal-life.

(1) It is a pity that some such plan has not been adopted in the guide to Salzburg. The authors have brought together a large number of facts, but insufficient attention has been given to their arrangement for reference. Paragraphs are often three or four pages long, and sub-headings are completely absent. The type is of monotonous uniformity, and lists of species are printed in continuity with the rest of the text. Two introductory chapters deal with the geography and the early history, but the former is mainly statistical. The rest of the book is a detailed local guide, traversing the country roughly in the order adopted in the corresponding Baedeker. Floral lists, often filling a whole page, are given at frequent intervals. If these had been replaced by an introductory chapter dealing with the botany as a whole, with especial reference to the altitude-zones of Alpine vegetation, it would have been sufficient to direct attention to exceptional local occurrences. In Salzburg the geological

facts can only be presented by the aid of numerous sections. There is not one in the whole book, hence the details given are usually very lacking in precision.

(2) *Saxon Switzerland*, the hilly district through which the river Elbe flows where it leaves German soil, is probably little visited by British travellers, although a favourite retreat for the holiday-making German. To geologists it was long ago made familiar by the works of Geinitz, and it is to the hard Cretaceous sandstones, eroded into many picturesque crags and precipices, that it owes its particular charm.

Being only one-ninth of the area of Salzburg, and of infinitely simpler geological structure, its description in a guide-book must have presented a much easier task. On the whole, Dr. Friese has arranged his facts very well. A number of interesting chapters, dealing with particular aspects of the natural history, occupy two-thirds of the book, the remaining third being a detailed guide traversing most of the area in twenty-four excursions. There are maps of the river-system, a simplified geological map, and numerous diagrams and sections.

Our Bookshelf.

- (1) *A Student's Manual of Organic Chemical Analysis: Qualitative and Quantitative*. By Prof. Jocelyn Field Thorpe and Prof. Martha Annie Whiteley. Pp. x+250. (London: Longmans, Green and Co., 1925.) 9s. net.
- (2) *Introduction to Qualitative Organic Analysis*. By Prof. Hermann Staudinger. Authorised translation by Dr. Walter T. K. Brauholtz. Pp. xvi+112. (London: Gurney and Jackson; Edinburgh: Oliver and Boyd, 1925.) 6s. 6d. net.

THE difficulty with which qualitative organic analysis can be systematised, and the fact that the properties of the various organic groupings can be learnt best by experience, has rendered the literature on this subject very meagre in comparison with the comprehensive works published on inorganic analysis. The two books under review are welcome additions to the literature, treating the subject, as they do, from different points of view.

(1) Profs. Thorpe and Whiteley's book, as the title indicates, is intended for the student. Those who have worked under the direction of the authors will recognise in it the substance of their advanced practical organic course, amplified and arranged suitably for use as a work of reference. It is intended that a student with an elementary knowledge of organic chemistry will be able, after steadily working through the tests, to recognise and estimate the more common compounds and groupings and will be competent, with a little specialised experience, to undertake any type of organic analysis. The book includes detailed descriptions of both historical and modern methods of elementary analysis, and also gives a most comprehensive and up-to-date compilation of the methods used in estimating the more common types of organic substances. The

qualitative reactions of the important organic compounds are tabulated with full experimental details in a form which will be found very convenient for reference. The book will be found invaluable to all students and lecturers of practical organic chemistry by reason of its completeness of experimental detail and excellent manner of treatment. The type and illustrations are excellent.

(2) Prof. Staudinger's book gives no experimental details. It presumes that the student has already a good acquaintance with both theoretical and practical organic chemistry and is only concerned with the methods of separating the constituents of organic mixtures and identifying the class to which they belong. It gives no specific tests for individual substances or experimental details in performing the operations. The book is more a theoretical discussion of the methods employed than a practical aid in the laboratory. While it will prove useful in showing a student the way to deal with difficult problems, the methods given are too elaborate for ordinary use when the student has obtained practical experience; for example, many pages are used in discussing how to separate liquid mixtures which can be identified by their odour in a few minutes. The book has been translated into idiomatic English very ably, the only outstanding peculiarity being the expression "mixed melt test".

An Introduction to Physical Geology: with Special Reference to North America. By Prof. William J. Miller. Pp. xvi + 435. (London: Chapman and Hall, Ltd., 1925.) 13s. 6d. net.

SEVERAL books on physical geology, with special reference to North America, are already available, but Prof. Miller's contribution to the existing literature is sufficiently attractive to justify its choice as a college text-book. Although no new ground is broken, the order of treatment differs somewhat from that usually adopted. River work, for example, is not touched upon until rocks, weathering, earth-movements, and structural features have been dealt with. Underground waters, again, are considered only after volcanic action has been discussed. The effort after logical treatment in geology can, however, never be wholly successful, whatever the arrangement. Since the study of processes includes that of the alteration and origin of rocks, and that of the concomitant development of land-forms, the aspects of physical geology fall into at least three dimensions, and a written account, which is of necessity unidimensional, must therefore involve both anticipation and repetition.

Like all recent books of its kind, Prof. Miller's is weak on the theoretical side, perhaps deliberately in view of the variety of hypotheses now under discussion. But some mention might have been made of the controlling importance of radioactivity in contributing to the heat of the earth and to crustal disturbances. The grouping of weathering with metamorphism is an example of placing the logical significance of words before that of the processes they connote. Familiarity with Crook's important paper on classification, a paper that has been strangely overlooked in the United States, would have prevented such an error of judgment. The ideal text on physical geology, even relative to

existing knowledge, has yet to be written, but of its class, Prof. Miller's work is thoroughly good, and its exceptionally full illustration by photograph and diagram is an added virtue which should ensure success.

Roman Folkestone: a Record of Excavation of Roman Villas at East Wear Bay, with Speculations and Historical Sketches on related Subjects. By S. E. Winbolt. Pp. xiv + 199 + 21 plates. (London: Methuen and Co., Ltd., 1925.) 8s. 6d. net.

IN this volume Mr. Winbolt describes his excavation of the Roman site discovered at Folkestone in August 1923. He suggests, with good ground, that we have here the remains of the official residence of the Roman Commander of the British Fleet, which came into being somewhere about A.D. 43, with headquarters at Gesoriacum (Boulogne) and stations at Dover, Lympne, and at times Newcastle, and was probably disbanded about A.D. 290. The size of the villa testifies to its importance, and strategic considerations make it improbable that it was a purely private residence, especially as there is no other private building known along this coast. Mr. Winbolt has made a very careful record of the finds and describes them in detail. Having the interest of the general public in archaeological matters in mind, he takes his readers into his confidence, and not only gives for their benefit extracts from his diary so that they may follow the progress of the excavation day by day and share his enthusiasm, but he also explains with great lucidity how each type of find bears upon the solution of the problems of the excavator. His book, therefore, may be commended to those who have no technical knowledge of Romano-British antiquities as well as to the expert.

Non-Metallic Minerals: Occurrence, Preparation, Utilization. By Raymond B. Ladoo. Pp. viii + 686. (New York: McGraw-Hill Book Co. Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 30s. net.

THE technology of the non-metallic minerals has not before been treated so systematically and comprehensively as in this book. Merrill's well-known book is essentially geological and mineralogical, but Mr. Ladoo gives us not only the physical properties and mode of occurrence, but also methods of mining, uses, and market values, together with much miscellaneous commercial information. The materials discussed are listed under nearly ninety headings, arranged in alphabetical order, and to each section a bibliography is appended. The volume closes with a more general bibliography and an excellent index, so that as a work of reference it is both a valuable compilation and an admirable guide to a literature that is comparatively little known.

The author has covered a wide field, and to keep the book within reasonable limits of size and scope he has properly omitted all fuels such as coal and petroleum, and all other "minerals" of organic origin. These, like the metallic ores, have an extensive literature of their own, and the remaining minerals, hitherto somewhat neglected, have now for the first time received really adequate attention.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Plotting Upper Air Temperatures.

SIR NAPIER SHAW has recently devised a method of plotting upper air temperatures in the form of a curve which he has named a tephigram (T- ϕ -gram). The curve is plotted on squared paper on which the abscissæ represent absolute temperature and the ordinates entropy or log potential temperature. The condition of a mass of dry air can be described as well by its temperature and potential temperature as by its temperature and pressure, and the tephigram in utilising this method has an advantage over the older form of pressure-temperature diagram in that the work which will be done by a sample of air in rising through any given environment when conditions are unstable is shown directly on the diagram as an area which may readily be measured by planimeter. Tephigrams are

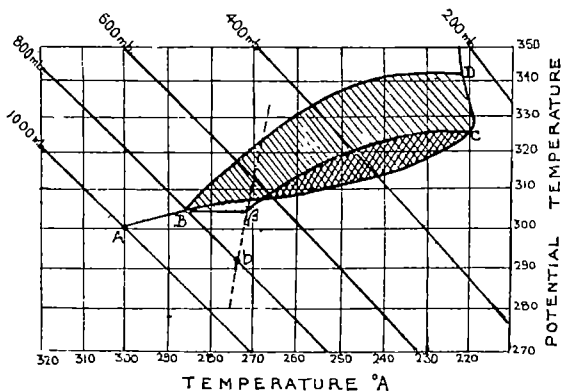


FIG. 1.

unfortunately somewhat difficult to comprehend at first sight, and are therefore unsuitable for presenting the results of upper air work to those who are not in close touch with the subject; but workers in this field of meteorology find that the graphs possess most of the advantages of the older pressure- (or height-) temperature diagram with the added advantage that, as explained above, they show the energy available from a sample of air placed in unstable surroundings at a glance.

If moisture did not exist in the atmosphere, the technique of plotting upper air data in the new manner might be regarded as fully worked out, but in all considerations of stability, moisture is of as great importance as lapse rate, and it is essential to indicate the water contents of the air by means of dew point or otherwise if the diagrams are to be of practical value.

To illustrate the following remarks a tephigram is sketched in Fig. 1. Potential temperatures are on the right of the diagram on a logarithmic scale, temperatures at the foot on a linear scale increasing from right to left, while lines of equal pressure slope down from left to right. Certain details have been omitted for the sake of clearness, only essential lines being shown.

The changes of temperature and potential tempera-

ture from the surface to the stratosphere are shown by the curve ABCD, the portion ABC where potential temperature changes but slowly being in the troposphere, while CD with its almost constant absolute temperature is in the stratosphere. If the air at the point marked B were saturated, the energy which would be liberated as one kilogram of the air rose from B to D is indicated by the whole area shaded on the diagram. The upper boundary of the area is an adiabatic line for saturated air, and it will be seen that as between B and D this line is everywhere to the left of the environment line ABCD, the rising air will throughout be warmer than its environment and will therefore have buoyancy and be capable of doing work as it rises.

The method of plotting humidities on the diagram which has been suggested by Sir Napier Shaw is to plot the dew point as well as the air temperature on each pressure line. Thus in the diagram B shows the temperature (286° A) at 800 mb. pressure and b the dew point (274° A). (See Q. J. Royal Meteorological Society vol 51, p 206, footnote.) The length of the line B b gives an indication of the dryness of the air. This method is probably the best that can be devised for showing the variations of humidity throughout an ascent, but it does not seem to be the most suitable for a study of the energy available in a mass of air rising from any particular layer. An alternative plan which appears to have advantages is to calculate the weight of water vapour per kilogram of dry air present in the air at B, and to mark the temperature β on the horizontal through B at which this weight of water vapour is the saturated content of air. Lines showing the number of grams of water vapour which will saturate one kilogram of dry air are printed on the tephigram paper (one is shown in the figure passing through b and β) and render plotting the point β easy. By this means the energy available in the actual non-saturated air at B is shown at once on the diagram, being the double shaded area which lies between the environment curve ABC and the saturated adiabat through β .

This is easily seen, for if a sample of air from B is raised in the atmosphere its temperature-potential temperature curve will run horizontally from B to β , where the sample will become saturated, thereafter it will follow the curved saturated line from β to C. During the first stage the air will be colder than its environment and work will be needed to raise it. During the last part of the course it will be warmer than its environment and will do work, as indicated by the double-shaded area. This method of plotting appears likely to have value in the study of instability in the atmosphere. It will make it plain that in many cases where large quantities of energy would be available if the air were saturated, in the conditions actually existing there is no energy available at all.

One criticism may be raised. On some few days the lapse rate reaches the dry adiabatic, and the environment curve ABC becomes for part of its course a horizontal line. Thus several successive points β may also fall on the same horizontal line, and it will be difficult to say which of the β 's corresponds with any one B. If, however, each point on the temperature curve is denoted by a separate letter, and each corresponding point on the moisture curve by a corresponding letter (B β , C γ , etc.), it will be easy to relate the two. It appears that if paper of a sufficiently open scale is used this objection need not be given too much weight.

J. S. DINES.

78 Denbigh Street, S.W.1,
October 15.

Bismuth Trihydride and Silver Bismuthide.

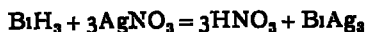
GASEOUS bismuth hydride was first prepared by Paneth (*Ber.*, 1918, 51, 1704), who obtained it by treating an alloy of magnesium and thorium C or radium C with 0.2 normal hydrochloric sulphuric acid. He afterwards (*ibid.* p. 1728) prepared somewhat larger quantities of the gas by the action of either of the above acids (but of four times normal strength) upon an alloy of bismuth and magnesium, carrying out the reaction in a heated iron crucible and in a stream of hydrogen. A mirror of bismuth was obtained when the issuing gas was heated as it passed through a glass tube. The gas was, however, never obtained in large quantities, and we have endeavoured to make a considerable amount of this hydride and from this substance to isolate the silver bismuthide, analogous to silver antimonide (*vide* Weeks, *Chem. News*, 1923, 127, 319, Weeks and Lloyd, *ibid.* p. 362).

In view of our results with the solid hydrides of arsenic and antimony (Weeks and Druce, *Trans. Chem. Soc.*, 1925, 127, 1069 and 1790) it seemed likely that bismuth trihydride could be obtained by reduction of bismuth dihydride with hydrogen.

Thus, when the dihydride was heated *in vacuo*, it decomposed evolving bismuthine.

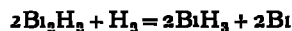


which could be decomposed on heating, with the formation of a mirror of bismuth. The gas was also drawn through solutions of silver nitrate to produce silver bismuthide, Ag_3Bi . The apparatus used in these experiments has been described in our communication to the Chemical Society on bismuth dihydride (*loc. cit.*). The most suitable reagent for absorbing bismuthine is ammoniacal silver nitrate solution, with which it forms a precipitate which was proved to contain only silver and bismuth. Analysis indicated that the composition of this compound corresponded closely with that demanded by the formula Ag_3Bi . The reaction is probably similar to the case of stibine and silver nitrate, namely:



Since the gas could never be obtained in large quantities by this method, we directed our attention to the reduction of the dihydride with hot hydrogen. For this purpose hydrogen was generated in the usual way and was purified by passing through solutions of lead nitrate, silver sulphate, potassium hydroxide, and potassium permanganate, and before being dried with concentrated sulphuric acid, it was passed through bulbs containing silver nitrate solution. These were inserted to ensure that the hydrogen contained nothing that would cause a precipitate to form with the silver nitrate used to react with the bismuthine which was obtained on heating the dihydride in this purified hydrogen. The gas issuing from the silver nitrate bulbs was ignited, and when the silver nitrate was largely decomposed, the flame assumed a steely grey colour and thin clouds of bismuth oxide were produced. Meanwhile, the silver nitrate slowly darkened with the formation of an almost black precipitate of silver bismuthide. It may be noted here that the bismuth dihydride must be free from traces of chloride, or silver chloride might be precipitated along with the bismuthide. This led us to prepare the dihydride by reducing a solution of a bismuth salt with aluminium and potassium hydroxide instead of the method described by us previously (Weeks and Druce, *Trans. Chem. Soc.*, 1925, 127, 1790). This product gave us a precipitate of silver bismuthide

uncontaminated with any silver chloride. The dihydride was reduced in accordance with the equation



Paneth has pointed out that the yields of bismuthine prepared from his alloys were very variable, and he concluded that the action of acids upon the alloys cannot be one of simple decomposition, since the best yields were obtained from magnesium which was merely coated with fused metallic bismuth. A possible explanation of this is that Paneth made a coating of bismuth dihydride upon the magnesium as soon as the acid acted upon the alloy. This view is supported by the work of one of us (E. J. W., *Chem. News*, 1923, 127, 87), in which it was shown that the yields of stibine from alloys of antimony and zinc appear to be independent of the composition of the alloy. It appears that the first action of the acid upon the alloy is the formation of the solid antimony hydride, which then decomposes in the following manner:



Silver bismuthide is an almost black crystalline compound, similar in appearance and properties to silver antimonide. It can be melted in a bunsen flame, and is unaffected by water or hydrochloric acid. It dissolves in warm dilute nitric acid giving but little bismuth trihydride, since further oxidation of this gas takes place.

The action $\text{Ag}_3\text{Bi} + 3\text{HNO}_3 = 3\text{AgNO}_3 + \text{BiH}_3$ is thus a reversible one, and this accounts for the difficulty experienced in absorbing the gas with aqueous silver nitrate. For this reason we employed ammoniacal solutions in order to remove the nitric acid as soon as it was formed. Silver bismuthide was also soluble in fairly strong hot sulphuric acid.

EDWARD J. WEEKS
J. G. F. DRUCE

Battersea Grammar School,
St. John's Hill, S.W. 11,
October 20.

Flowering Plants as Epiphytes on Willows and Alders.

SINCE April, when trout fishing on many occasions in the river Chew, which enters the Avon between Bristol and Bath, I have been impressed with the large number of flowering plants, or Phanerogams, growing as epiphytes on pollard willows and alders by the river-side. I have listed about 103 species, in addition to the common Polypody fern. Some of these are of considerable interest in their strange habitat, and a single plant of *Lysimachia vulgaris* and two of *Nasturtium sylvestris* appear to be unrecorded species from the whole valley. The latter was also seen in the bed of the river during the drought of June.

The Chew extends from Chewton Mendip and East Harptree, Somerset, to Keynsham, a distance of about nineteen miles, or ten as the crow flies, and with a fall of about 400 ft. It is subject to heavy floods, and the average rainfall in the upper region is several inches greater than that at Clifton (35 inches) or Bath (30.84). The river rises rapidly, and occasionally to a height of eight or even ten feet above the normal summer level.

Doubtless the majority of the plants have been brought down and left stranded by floods, but not a few have been brought by birds, which are frequent in the valley, and several by wind dispersal of the seed. Cows, drinking and wading in some of the shallows, may be responsible for others. Many of

the trees have a considerable accumulation of humus, so that some of this vegetation may be regarded as well established.

Weeds of cultivated ground are few, for there is very little arable land in the valley, it being chiefly meadow or pasture. There are several mixed plantations near Compton Dando, three or four miles from Keynsham, but few woodlands in the upper part, except near the source of the stream. The number of woodland as distinct from hedgerow plants hitherto seen is extremely small. Ninety per cent. of the total plants have been noted between Keynsham and Compton Dando.

There is an apparent absence of any Leguminosæ—not even a vetch, clover or Lotus was observed. Many of the leguminous seeds would sink in water. Seeds (even from herbarium specimens) of practically all the British vetches and many others of that family sink in water, as experiment this autumn has proved. Compositæ is only moderately represented; but the comparatively large number of umbellifers is noticeable. The fact that no monocotyledons were seen, save *Juncus bufonius* and *Luzula campestris* (once) and a few grasses, is not surprising, except the paucity of grasses.

At least a dozen kinds of woody plants and shrubs have got established, namely, dog-rose, ivy, blackthorn, hawthorn, gooseberry, sycamore, elder, a small elm, ash, alder on two willows, and two or more species of Rubus in many places. No holly has been seen, nor maple with its winged samaras.

On April 30 I counted twenty-three Phanerogams, three mosses and two liverworts on a single old willow fallen half across the stream. These include *Ranunculus Ficaria*, *Arenaria trinervia*, *Rosa canina*, *Angelica*, *Conium*, *Anthriscus sylvestris*, *Torilis Anthriscus*, *Tussilago Farfara*, *Petasites ovatus*, *Symphytum officinale*, *Scrophularia nodosa*, *Stachys sylvatica*, *Nepeta hederacea*, *Plantago lanceolata* and three grasses, one of which proved later to be *Deschampsia cespitosa* in two fair-sized clumps.

There are a number of quite handsome plants in these lists, such, for example, as the comfrey, meadow cranesbill, hemlock, angelica, teasel, meadow-sweet, hemp agrimony, purple loosestrife, great mullein, and the picturesque woolly-headed thistle (*Cirsium eriophorum*), of which one poor specimen appeared. This most handsome thistle is very abundant on a steep bank overlying the Lower Lias, which descends in a great tongue-shaped mass almost to the river near Chewton Keynsham. It was from numerous dried specimens from this locality sent in 1922 to Dr. Petrak in Czecho-Slovakia, when monographing the genus, that his belief was confirmed that the English form differs slightly from the Continental. He has therefore called it sub-sp. *britannicum*. It is frequent in Somerset on the Lias, Keuper marls and Oolite, and was first noted in the county and for Britain by Lobelius in 1570.

Among the other plants growing upon some of the trees are *Thalictrum flavum*, *Ranunculus auricomus*, *R. acris*, *Nasturtium officinale*, *Brassica Rapa* (abundant and possibly native by the Chew), *Barbarea vulgaris*, *Cardamine pratensis*, *Viola Riviniana*, *Stellaria aquatica*, *S. neglecta*, *Lychnis dioica*, *L. Flos-cuculi*, *Geranium Robertianum*, *Geum urbanum*, *Adoxa Moschatellina* (once), *Galium Cruciata*, *Valeriana officinalis*, *Bidens tripartita*, *Lactuca muralis*, *Lysimachia Nummularia*, *Solanum Dulcamara*, *Prunella vulgaris* and *Ajuga reptans*. From these abridged lists most of the smaller plants and a few annuals have been omitted.

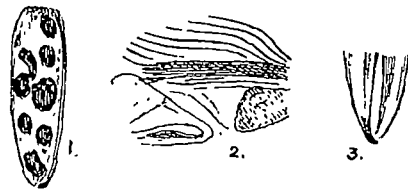
H. STUART THOMPSON.

33 Southleigh Road, Clifton,
October 20.

Tertiary Fossil Insects from Argentina.

A FEW years ago Mr. Geo. L. Harrington, of Buenos Aires, was prospecting in the Santa Barbara district of the Province of Jujuy, Argentina. In this region we find deep gulches with good exposures of the geological formations. A very conspicuous and important formation consists of green rock, easily breaking up into small angular fragments, commonly with conchoidal fracture. In its upper part it shows streaks of red, increasing until we reach an entirely red deposit. We interpret this as indicating increasing aridity, culminating in desert conditions with wind-blown sands. The red rock appears to be without fossils, and above it is a great mass (possibly 2000 feet) of yellowish deposit of more recent date. Dr. G. Bonarelli (1921) placed the green rock in the upper division of his Calcareo-Dolomitic horizon, but owing to the absence of fossils the age remained unknown. Mr. Harrington, following up the gulch which runs west from Sunchal, came upon a little deposit of fossil insects, and collected a number of specimens. Most of these were eventually transmitted to the U.S. National Museum, whence they were sent to me for study. They were found to consist of seven species of beetles and a caddis fly, almost certainly of Tertiary age. The horizon was in the typical portion of the green formation, where it is interbedded at intervals with heavy limestone.

This discovery was of quite extraordinary interest, as these were the first Tertiary insects ever found in South America, if we exclude a couple of small flies in amber of unknown age. My wife and I decided



1, *Cerambycites wilsoni*; 2, *Gryllus vociferans*;
3, *Psalis pachyura*.

that we could not spend the summer of 1925 better than by visiting the spot where there was a reasonable hope of further discoveries. Accordingly, after various adventures which it is not necessary to relate, the month of July saw us established in a small tent at Sunchal, within half an hour's walk of the insect beds. The locality proved interesting in many ways; the neighbouring slopes showed large columnar cacti, *Trichocereus terscheckii* (Parmentier) and *T. pasacana* (Weber), while the gulches were full of splendid trees, among which were flocks of green parrots. Sunchal proved to consist of a single, very poor ranch, with a few suburban sheds. We soon found Mr. Harrington's locality, as well as another not far away. In the course of several days we obtained a considerable collection of insects, mostly elytra of beetles. We also got a well-preserved fish, a species of *Corydoras*, a cat-fish of the family Callichthyidae. This represented a family of fishes not before found fossil. The general outcome is that the deposit is unquestionably fresh-water Tertiary, but the more exact position will have to be considered when the collections have all been gone over. The general impression is that the fauna is not very ancient, yet in some respects it recalls the Upper Eocene fauna of North America.

So far, we have only relatively small species of insects, with nothing specially characteristic of the

tropics I give figures of three of the most interesting. Fig. 1 is a cerambycid elytron, 9.5 mm long and 3 mm. broad, with large brown spots, the edges of which are darkened as in *Eburia*. It was found by my wife at our Station 2. I call it *Cerambycites uhlnallæ*, placing it in the blanket-genus *Cerambycites* because it cannot be definitely referred to a modern genus known to me. Fig. 2, which I call *Gryllus vociferans*, is part of the tegmen of a small male cricket, the part shown being only 4 mm long, the veins sepia brown. It is probably not a *Gryllus* in the strictest sense, but it is of particular interest as showing the male vocal organs fully developed, as in modern forms. This does not necessarily indicate a very recent age for the deposit, as similar specimens (three species) have been found in the Oligocene of the Isle of Wight. Fig 3 shows the forceps of an earwig, *Psalis pachynura*, the forceps reddish brown, 3.3 mm. long, simple, broad at base. The genus *Psalis* is doubtless an old one, being found on both sides of the world. I had referred the fossil to *Psalis* in a broad sense; and Mr. J. A. G. Rehn, to whom I sent a sketch, independently reached the same conclusion: "I should say from your sketch it would clearly be *Psalinæ*." These are the first orthopteroid insects found fossil in South America.

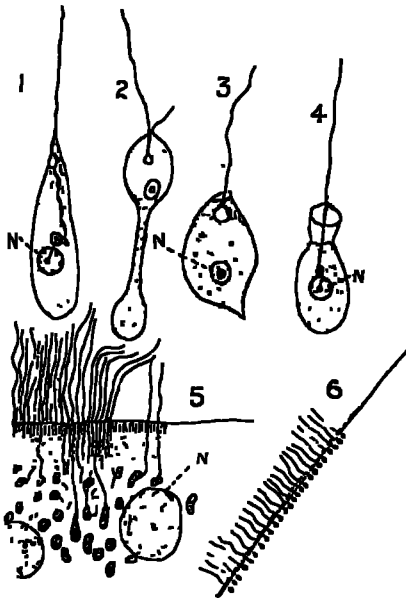
Now that attention is directed to these beds, others will doubtless investigate them, and we may expect to learn a great deal about the Tertiary insects of northern Argentina.

T. D. A. COCKERELL

University of Colorado,
Boulder, September 29.

Opalina ranarum: a Flagellate.

MINCHIN, in his well-known volume, "An Introduction to the Study of the Protozoa," 1912, states that the species of the genus *Opalina* differ in certain peculiarities of structure and life history from all other ciliates. The life history has been studied by Metcalf and Neresheimer, whose accounts agree as



regards the general life history, but differ in some cytological details.

Neresheimer considers that the life-cycle of *Opalina* proves its affinities are with the Flagellata rather than with the Ciliata. This view did not find favour with Minchin, who placed *Opalina* in its usual position.

Recently we have carried out some work on *Opalina*, and have obtained results which we believe show conclusively that this protozoon is really a flagellate, as Neresheimer suggested from his study of the life history.

In a flagellate (Figs. 1-3, from Minchin) the flagellum nearly always passes into the substance of the organism and ends in a bead, vacuole, cyst or special granule of some kind. In various flagellates the granule may be specially well marked as a "solid," well-defined structure; in others it is apparently associated with a cyst of some sort.

In the typical ciliate, the cilia are almost invariably short structures arising from cortical granules which are nearly always quite small (Fig. 6). We know, however, of cases where the cilia have been described as entering right into the substance of the organism, and even impinging upon the nucleus, but such cases are rare, and unlike typical flagella.

Now, in *Opalina ranarum*, the "cilia" enter right into the substance of the organism, and take their origin from the peculiar granules which exist in very large numbers in the protoplasm of *Opalina* (Fig 5).

This system exactly resembles the arrangement in the choanocytes of *Grantia compressa* and *Spongilla* (Fig. 4) as described by Hirschler and Gatenby. We claim, therefore, that the motile organs of *Opalina* are flagellar in nature, and that this protozoon should be classified among the Flagellata.

J. BRONTÉ GATENBY.
S. D. KING.

Trinity College, Dublin,
October 28.

The Geographo-Economic Institution at Leningrad.

IN 1919 the leading professors of the Geographical Institution, Leningrad, conceived the idea of creating a scientific institution for research upon geographical questions in which young men and women students of the Geographical Institution were to co-operate. From this sprang a "Scientific Collegium," which in 1923 was reorganised and named the "Geographo-Economic Institution."

This Institution is now under the direction of Prof. S. Sovietov and has eight departments: (1) Plant Geography, (2) Soil Science, (3) Zoo-geography, (4) Geophysics, (5) Economic Geography, (6) Geology, (7) Geography, (8) Ethnography. There are about thirty fellows and forty assistants now working in all departments. The principal work of the Institution is field studies. All the fellows and assistants are engaged during the summer in different parts of Russia, and during the winter the results of their work are discussed at the meetings of the Institution. This makes a very valuable training for young scientific workers in preparing them for responsible scientific positions. As Russian literature is very poor in good field manuals, the Institution has just published a handbook entitled "How can the Country be Studied?" Another large publication, a Geographical and Economic Atlas of the Leningrad country, is in preparation. This work will contain maps showing the distribution of different climatic and soil factors as well as of the various organisms—plants and animals, and of different peoples and their cultures.

The Institution has its own publication, "The Phyto-Geographical Atlas of the World," and would be glad to establish scientific relations with other similar Institutions of the world. The address is: Leningrad, Mramornyy Dvoretz (Marble Palace), Geographo-Economic Institution.

BORIS FEDTSCHENKO.

Some Modern Aspects of Physical Research.¹

By Sir ALFRED EWING, K.C.B., F.R.S.

IN this ancient and honourable Royal Society, we have an association of persons with a common motive, namely, to assist the advance of natural knowledge. The chief functions of such a society are (1) to provide facilities for intercourse, personal and formal; (2) to provide a library—and we have a great library of ever-increasing value, (3) to provide the means of publication. Records of scientific research are not a readily marketable commodity. They would fare badly if left to the mercy of the ordinary laws of supply and demand. So we meet the cost of publication, and they go out, after some winnowing of chaff from wheat, with our imprimatur. The published volumes of our Proceedings and Transactions contain papers by Kelvin and other fellows which may be said without exaggeration to mark epochs in the development of scientific thought.

The urge which we feel towards research—that urge which is our bond of fellowship—is not mainly utilitarian, it arises rather from a special type of intellectual curiosity. Often indeed the results of research undertaken with no utilitarian purpose have been found to possess a utility that was not in the mind of the discoverer. For example, Kelvin's theory of the oscillatory discharge of electricity, followed by Maxwell's recognition of electromagnetic waves in the ether, and by the detection of such waves by Hertz, though matters of purely scientific interest at the time, led in due course to wireless telegraphy and broadcasting. Again and again in the history of discovery an abstract research has turned out of quite unlooked-for practical value.

We may recognise, I think, two general types of research, both of which it is the business of a scientific society to foster. There is the inspired type—the flash of genius, of intuition, of imagination, which breaks new ground or brings the old into a new harmony by some far-reaching generalisation. There is also the plodding everyday systematic spade-work of research; a kind which goes on in a hundred laboratories; not inspired, not spectacular, not in the least intoxicating; but we should make a grave error if we were to underrate its importance.

Such a society as ours is, consciously or not, in some degree propagandist. One of its effects is to spread an interest in science beyond the bounds of the scientific workers. There is already a changed attitude on the part of the public towards scientific ideas and the scientific method. Formerly the voice of the specialist was that of one crying in the wilderness; now he commands the attention of the man in the street. In the training of engineers, in the carrying on of manufactures, in many different fields of social activity, we trace the permeating influence of science. Young men leaving the universities with a knowledge of scientific principles and able to manipulate scientific instruments are quickly absorbed into industry. One sees great industrial concerns setting up their own research laboratories, and finding that it pays them to do so. Research has found a place not only in manufacture

and industry, but also in the budgets of the politician. The Government endows individual researchers and encourages corporate efforts in various administrative departments, notably through its Department of Scientific and Industrial Research. The activities of that department are perhaps not so well known as they ought to be. Such an organisation can successfully undertake researches of a kind impossible for isolated workers. I have some personal knowledge of its work, for I am at present chairman of two of its scientific committees. One of these deals with the effects of moving loads in producing stress in railway bridges. This is an investigation which no private individual could conceivably have carried out: it needed, and has in fact received, the active co-operation of the railway companies. It is a long and costly inquiry, but I am able to say with confidence that the results already secured are such as to justify the expenditure, by the influence they will have on the future design of bridges and locomotives.

Looking back, it is curious to note the progress in pure and applied science that has come about within the period of my personal recollection. I am old enough to recall the very beginnings of electrical engineering, the first use of electric lamps, the first transformers and storage batteries, the first attempt to produce and distribute electric power. In student days I exhibited at a bazaar the first telephones of Graham Bell's invention, which had been brought across the Atlantic by Lord Kelvin. It happened too that, guided by a brief description in the *Times*, I made the first Edison phonograph ever made on British soil, an invention which has given us the advantages (if you so regard them) of the gramophone. I remember too the earliest form of motion pictures, from which has come the ubiquitous cinema. My memory goes back to the most primitive type of internal-combustion engine, the development of which has given us motor cars, and has made flying possible. It goes back also to the earliest application of refrigeration, which is now playing so large a part in bringing our food from overseas.

It was my privilege while a young professor at Cambridge to test for Parsons his earliest condensing steam turbine, and a little later his first turbine-driven steam-boat. The invention of the steam turbine, which we owe to Sir Charles Parsons, has been applied on a gigantic scale not only for ship propulsion, but also for the distribution of electric power from central stations. I recollect vividly hearing, in the early 'seventies, Lord Lister describe to this society his antiseptic method in surgery, and seeing him take from a sterilised flask its plug of cotton wool and drink down the milk it contained—milk which he had drawn from the cow three months before. Later came the two cardinal discoveries of radioactivity and the X-rays. Both of these soon became handmaids of surgery; but apart from that, they put novel instruments of unparalleled effectiveness into the hands of the physicist. Think of what all this discovery and invention has meant in making Nature more man's servant, in prolonging his life, in giving him more of comfort, of interest, of power.

¹ Presidential address delivered before the Royal Society of Edinburgh at the annual meeting on October 26

Younger men, who have been born into a world where these things are already familiar, cannot realise the excitement and delight of an earlier generation in seeing them spring, new and strange, from the brains of their creators.

•

Bliss was it in that dawn to be alive,
But to be young was very heaven!

I was really in middle life when, in the last decade of the nineteenth century, the great physical renaissance began, of which radioactivity and X-rays were the two chief starting-points, opening up as they did new vistas of thought as well as furnishing new tools for research. J. J. Thomson had shown in 1881 that a charged body derives additional inertia from the existence of the charge, but it was not until after his discovery (in 1897) of the electron as a disembodied atom of electricity, an indivisibly small unit, that it became apparent that all mass is electrical in origin. We used in older days to aim at explaining electricity in terms of matter; now we have come to regard matter as one of the manifestations of electricity. We recognise that the atoms of all substances are complex structures, which are built up out of only two kinds of brickbats, positive and negative units of electricity, called respectively protons and electrons. The positive brickbats, the protons, contribute nearly the whole mass, and it comes from the concentration of electricity into a very minute space. We may perhaps think of the protons and electrons as being electrified holes in the ether, imagining the proton hole to be about eighteen hundred times smaller in diameter than the electron-hole in order that it may have a sufficiently bigger mass. But I must admit that to suggest a definition of the ultimate particles of matter as electrified holes in a medium which perhaps does not exist, is more stimulating to the imagination than satisfying to the intelligence. Whatever the protons and electrons may be, they build up the atom in what Rutherford has taught us to regard as a sort of planetary system. There is a nucleus which contributes nearly all the mass. It is positively charged because it contains all the protons and only some of the electrons. The remainder of the electrons, in number equal to the positive charge, are disposed outside, much as the planets are disposed around the sun.

This conception of an atomic structure has led to the grouping of the elements in a systematic series, rising in regular steps by one unit of positive nuclear charge as we pass from one element to the next. The number of units of nuclear charge gives the atomic number of the element, and it goes progressively up from hydrogen = 1, helium = 2, lithium = 3, and so on, up to uranium = 92, forming a continuous series in which there are only two or three gaps still waiting to be filled. Towards this idea the way was paved by Barkla's discovery of the characteristic radiation of substances under bombardment by X-rays. The splendid generalisation of the atomic series was itself reached through the inspiration of Moseley. It justifies Prout's old hypothesis, the objection that the atomic weights of the elements do not come out as whole numbers having been completely removed by the discovery of isotopes, the discovery, namely, that some elements are mixtures of two or more substances having the same chemical

properties, but with integral differences in their atomic weights.

More or less concurrently with these developments of atomic theory came the recognition of series in the lines of optical spectra, initiated in 1885 by Balmer, a teacher in a secondary school at Bâle. His work was followed up by Lyman and Rydberg, and is now interpreted, thanks to the genius of Bohr, in a manner which connects the spectral lines with the complex atomic architecture of Rutherford. In this interpretation the quantum theory, which had been framed by Planck in 1900 to account for other and quite different phenomena, has received so complete a confirmation that we are forced to accept it as a rule in Nature's operations, although at present it is a rule we cannot understand.

In the hands of the Braggs, father and son, X-rays have served to show exactly how the atoms take their places in the tactical groups which constitute crystals. The whole development of modern atomic theory is a chain of discovery connecting phenomena that were previously separate, stretching link by link into regions that had seemed hopelessly outside the pale of exact knowledge. No one surely foresaw that it would be possible to weigh and measure the constituent particles which make up an atom.

Other romances of science are to be found in the recent progress of astronomy. A new departure was taken by Michelson in 1920 in the success of his device for measuring the sizes of certain stars. He found, for example, that in Betelgeuse we have a celestial giant two hundred million miles in diameter, big enough to take in the whole orbit of the earth, and more. This diameter had been foreseen by theory. In particular, Eddington has applied his imagination and his mathematics to the question. He shows that the surface temperature of a star is no criterion of the fervent heat within, where a temperature of perhaps twenty million degrees may be reached. Under such conditions the energy of the star is about equally divided between the energy of waves of radiation and that of the motion of particles. The radiation causes a disruptive pressure which acts against gravitation so strongly that the balance between those two forces is the factor which determines how much mass is condensed to form a single star. This explains why it is that all stars are roughly of the same order of magnitude.

Eddington pictures the radiant energy within the star as trying to escape into surrounding space but caged in by the material. It is tossed to and fro from atom to atom as the ball is tossed in a Rugby match, and only little by little does it reach the surface and find itself free. He shows how at the enormous temperature of the interior the atoms are stripped of their outer electrons, which then mingle in the throng as free particles. Deprived in this way of the crinoline or fender of electrons that would normally keep them apart, the nuclei may approach one another far more closely than they could otherwise do, and the star may therefore contract to a density which vastly exceeds that of any substance known in our laboratories. But in contracting from a giant to a dwarf, the substance of the star preserves the essential features of a gas, for the particles have still a relatively large mean free

path of movement in the intervals between their encounters. Owing to the removal of their crinoline, stellar atoms have only something like one-hundred thousandth the bulk of ordinary atoms, and so may be brought immensely closer to one another before the properties of a nearly perfect gas are lost. Finally, Eddington gives us reasons for imagining that in the course of its life history the star maintains its power of emitting radiation not simply by virtue of its contraction, but by converting into energy a portion of its own mass. His remarkable prediction as to the density of dwarf "white" stars has, during the past summer, been verified by Adams at Mount Wilson, who, by measuring the "relativity" displacement of lines in the spectrum of the companion of Sirius, has proved that star to have a density some two thousand times greater than that of platinum, and has directly confirmed the validity of the spectral shift as a test of Einstein's general theory of relativity.

Yet another romance is the story of helium, first inferred as an element in the sun by Lockyer in 1868 from observations of the spectrum of a solar prominence. It was not known to be a constituent of the earth until Ramsay found it in 1895 as a gas in the mineral cleveite. It takes an important place as the second member of the atomic series, the lightest of the group of inert elements which includes neon, argon, krypton, and xenon. It is found in small quantity in the atmosphere and in nearly all natural gases and spring waters. We now recognise it as a product of the disintegration of radioactive substances. Each alpha particle they shoot out is essentially an atom of helium. It is the nucleus of such an atom, which only requires to associate itself (as it can readily do) with two planetary electrons in order to become a complete electrically neutral atom of helium. The lightness and inertness of helium make it an ideal substance for the filling of airships, for it has a lifting power in the atmosphere not far short of that of hydrogen, along with the immense advantage of being completely unflammable. Helium is now assiduously collected from its natural sources for this practical purpose. From the point of view of theory it is also particularly interesting. As an agent for producing the extremest degree of cold it has been used by Onnes, who, by vaporising liquefied helium, has reached a temperature only about two degrees short of absolute zero. One may remark in passing that the absolute zero of temperature is almost the only absolute thing that is left to us in a universe given over to relativity.

Rutherford has put helium to another scientific use. He employs the alpha particle, which is the nucleus of helium, projected from a heavy radioactive substance

with a velocity of ten or twelve thousand miles per second, as a projectile with which to knock chips off the nuclei of nitrogen and certain other elements. In this way he produces hydrogen, for the chips which are knocked off are single protons, each of which forms the nucleus of a hydrogen atom. Thus in the hands of Rutherford the alpha particle is a veritable philosopher's stone by which the transmutation of elements, so long the dream of the alchemist, has become an accomplished fact. Quite lately we were told of laboratory experiments in which gold was reported to have been made by the removal of part of the nucleus of the element next above it in the list, namely mercury. The news was received with perfect calm by the scientific world, and even, I fancy, by the Governor of the Bank of England. For if you want gold it will doubtless be cheaper to find it by digging than to make it in that way.

There have been so many surprises in physics that the faculty of wonder is almost exhausted. Things have happened which a little while ago would have seemed to be miracles. We may think of Kelvin or of Tait as turning in his grave when an occupant of this chair speaks of there being no strict conservation either of matter or of energy, and accepts the possibility of transforming the one into the other. The foundations of the older physics have been rudely shaken, and the effect of such upheavals has been to alter the temper of the scientific mind. The old positiveness has gone. No longer are we positive about anything. The complacency, the facile dogmatism, which here and there showed itself in the last century, is now a rather absurd memory.

We are confronted by dilemmas and find no way out. We are obliged, one may say, to take the dilemma by the horns, boldly grasping both. The electromagnetic theory of light, established as we believed by Maxwell, is confronted with the view that there is no ether, nothing which will serve, in the words of the late Lord Salisbury, as a nominative to the verb to undulate; and, worse still, while the wave theory is amply supported by the facts of interference and diffraction, it is apparently inconsistent with the equally well-established facts of absorption and photo-electricity. How to reconcile these seeming contradictions we simply do not know. So while we may justly feel pride in all this progress and achievement, it is mingled with a consciousness of mystery, with a spirit of question. In a special sense is it true to-day that the widening of the circle of light has widened the circumference of darkness, and for the moment at least the darkness seems strangely impenetrable.

The Science and Art of Map-making.¹

By A. R. HINKS, C.B.E., F.R.S.

THE progress of invention has placed in the hands of surveyors a number of beautiful new methods, and some we have not yet scientifically explored. Would you measure a base? So far from painfully seeking a dead-level plain and clearing it of every petty obstruction, you will gaily take the suspended invar

tapes across country, and by preference run them up a hill at each end to get a better view for the base extension. Would you equip a party for primary triangulation? Look thankfully at Ramsden's 36-inch theodolite reposing in the museum of the Ordnance Survey; look doubtfully at the fashionable 10-inch; and before you take it any more into the field, examine whether the instrument of the future is not a 5-inch

¹ From the presidential address delivered at Southampton on August 27 before Section E (Geography) of the British Association

constructed on the new principles of Mr. Henry Wild, with circles etched on glass, and parallel plate micrometer that reads opposite points of the circle from the eye-end and takes the mean for you. When you lay out the triangulation, consider well the recent opinion of the U.S. Coast and Geodetic Survey, that it is better to be content with small triangles easily accessible, with automatic electric beacons tended by a party in a car, than to make enormous efforts at rays longer than Nature easily allows. Bear in mind also a remark which our lamented friend Col. Edmund Grove-Hills made to me not long before his death. I was saying how necessary it was to complete as soon as possible the late Sir David Gill's great arc of meridian in Africa; and to my horror Hills referred contemptuously to the meridian arc as an "obsolete method." He did not pursue the idea; but I think we can see what was in his mind, and that he was right. The old-fashioned arc stuck to the meridian or the parallel with a sublime disregard of the topographer's convenience. It had infrequent bases measured with pomp and ceremony. It had occasional astronomical latitudes and azimuths observed with an almost painful degree of internal precision by heavy instruments and prolonged sojourn on uncomfortable heights.

We can see now how mistaken it all was. The purpose of these astronomical observations was to compare the geodetic with the astronomical latitudes, as a contribution to the Figure of the Earth. But what use to aim at single tenths of seconds in the latter, when on the average they were divergent by several seconds owing to local deviations of the vertical? Our real need is for a latitude at every triangulation point, and those points thick upon the ground. "Obsolete" was Hills' word for the meridian arc; and I think we shall not find it too strong, when we look at a graphical plot of the contribution to our problem which Gill's arc in South Africa can make.

It seems that we shall be driven back to the old network stretching far and wide across the country like the triangulation of Great Britain; and that raises problems which can scarcely be discussed here. But let me not for one moment be taken as disparaging the practical value of Gill's great achievement. It has proved invaluable as a framework on which to hang boundary surveys. It stretches a long skeleton from Port Elizabeth to near Tanganyika—ready to be clothed with topographical maps; and still lying in stark nakedness, for there is something in self-government that is antipathetic to map-making. Our Crown Colonies are getting fairly well provided with maps, thanks in great measure to the work of that Colonial Survey Committee which was so active early in the century, and which we hope was not a casualty in the War. But our self-governing Dominions have not always much to boast of.

This is a well-worn subject, and geographers are getting tired of asking whether there is yet a single topographical sheet to be bought in Australia. I believe that the answer is still, No: though there are some thirty sheets for official use produced by the Department of Defence as an earnest of the thousands that are wanted to cover the continent. Canada has now a first-rate geodetic survey and the beginning of a good topographical map; but it is a big country that

began survey very late, and its settlement is marching faster than its maps. Thanks to the labours of Mr. Wallace, we do know at last, what Lord Southesk never did, where he went on his journey of 1859 in the Rockies, but there is still no published map good enough upon which to show the route.

It is a commonplace of books that the surveyor in the field can always find latitude or azimuth, but is in difficulty with his longitude. That is no longer true. The rapid establishment of powerful time signals has made it possible to get longitude as exactly as latitude, and this must have a profound effect on further survey, exalting the astronomical at the expense of the trigonometrical; facilitating marvellously the rapid reconnaissance survey; putting off the drastic remedy of triangulation; but heaping up trouble in the future. On the other hand, the method of wireless longitudes will tend to the solution of two great problems, one of respectable position and one a little parvenu. Is the equator a circle? No one has yet certainly challenged it, though Clarke and others have done their best with inadequate means. Are the continents floating, or rather sliding about slowly on a *sima-slide*? We are generally agreed that Wegener has not proved his case, because he had a naive trust in astronomical longitudes palpably weak. Yet the question has been deemed worthy of a serious and costly enterprise, warmly advocated by General Ferrié, and gradually assuming, I think we may say, without offence to that great enthusiast, a much more acceptable shape than the rather hard and unadaptable outline that was a little criticised by British geodesists and astronomers two years ago.

The need of a strong central authority is as evident in wireless time signalling as it is in the organisation of broadcast. Happily for geographers, the astronomers have organised themselves well since the War into a Union with thirty-two Commissions. The Union spends half its whole income on the sustenance of the Bureau International de l'Heure, over which one of the Commissions exercises a general control. The prodigality of the Union, stated thus, is impressive. In cold fact, its contributions, fixed unfortunately in French francs, do not go very far to pay the cost of the service, which can be carried on only because the Director of the Paris Observatory has not hesitated to place the instrumental resources and the magnificent house-room of his Observatory at the disposal of the Bureau; while the keen interest of General Ferrié has secured the benevolent and beneficent co-operation of the French radio-telegraphic services, military and civil. Geographers owe a great debt of gratitude to the French in this matter. But we hope that the British Government will not rest content with the modest part which Great Britain has played up to the present in this great development. We have—or shall have soon—an "Imperial Wireless Chain" stretched out from the new station at Rugby to the farthest Dominions; and we shall miss a great dramatic opportunity if from the opening of this service we do not insist that time signals from Greenwich shall be sent from Rugby and retransmitted in each link of the chain, that all Britain's Dominions beyond the seas, her ships on the ocean, and her travellers wherever they may be, shall be able to take Greenwich Mean Time direct from

the source. The technique of time transmission has been so greatly improved in these last years that there is no serious difficulty about it; and of the Imperial services for which the Rugby station is built, there can be none, I think, more really, if modestly, useful than the propagation of Greenwich Mean Time throughout the Empire.

The science of cartography is based upon the sciences of precise survey, and I make no apology for having dwelt for some time on the methods of securing the foundations. But when these are well and truly laid, it is time to press forward the visible building—the maps—and a problem we share with the larger world is that of building with speed and economy, not regarding too closely the interests vested in the old methods, but prepared if it seems wise to reinforce the ancient crafts with new. Two new powers have been added to the cartographer in these last years: flight to give him range of vision, and the stereoscopic plotter to give his photographic vision a new sense. For I do not exaggerate when I use those words—a new sense—to describe the power which the stereoscopic measurement of pairs of photographs has given the surveyor of topographical detail. The brilliant idea that this could be done automatically was due to Capt. Vivian Thompson. The credit of extending and perfecting the beautiful but marvellously simple geometry belongs to an Austrian, Lieut. von Orel; and of translating the geometry into sweetly working mechanism to the German firm of Zeiss. No more beautiful piece of optical machinery has ever been made, I willingly believe, than the stereoautograph of von Orel and Zeiss. But they made a sad mistake in marketing it, granting exclusive rights over a territory to an individual, and demanding from him not only a heavy price for the outfit, but also a large and perpetual royalty on his gross receipts as a stereoautographer. So strange a method of selling a scientific instrument was never known before.

Happily there is more than one mechanical and optical solution of the problem, and at least four different machines are now in the field abroad, while a fifth is under construction in Great Britain to the order of the Air Survey Committee. We are thus fortunately saved from the reproach that nothing has been done in this our country to develop a method first devised by an Englishman. But we may feel that our instrument-makers and our surveyors have been a little unenterprising, and there is nothing I would like to see more than a real effort, with adequate means, to try out stereographic surveying on geographical scales.

We know well enough that the stereoautograph can deal marvellously with a small piece of country on a large scale; but what has never yet been shown is that it can deal with a large piece of country on a small scale. It will contour for you an inaccessible cliff at 1-metre intervals on the scale 1/5000; but can it or a rival be made to tackle 100-metre intervals on the scale 1/250,000? That is a question which has never yet been answered, and I believe that it is our duty to answer it. Along the northern frontiers of India in the ranges of the Himalaya are at least 10,000 permanently snow-clad peaks. So long as the inch-to-the-mile map is incomplete in the plans, we can scarcely expect it in the mountains. Yet a really accurate map on the scale, say, 1/250,000 cannot be deemed superfluous for de-

fence; and even the poor geographer or traveller is entitled to ask for it. How is it to be obtained? Will stereoscopic survey do anything for us?

I feel certain that the answer is Yes; but much less certain that the photographs should, at least in the first instance, be taken from the air, which seems to be contemplated by the advanced school, and taken for granted by the newspapers. Air photography made a brilliant success in the War, when the cost was not too severely scrutinised. In peace we have to approach the problem with the fear of the Treasury in our hearts, and with more respect for that sort of precision which lets one go on in an orderly way for ever, without leaving accumulations of errors "to be absorbed in the desert," as they say in the Sudan.

Now, photographs taken with axis vertical cover a surprisingly small ground, even from extreme heights. With a lens of 6 in. focal length, about the minimum, you must go to 25,000 ft. to get a result on the scale 1/50,000, and then you can photograph only about three miles square on each plate. Flying at 90 miles an hour you must take plates every few seconds to avoid getting too much stereoscopic relief. It looks as if vertical photographs combined stereoscopically will fail in mountainous country.

I turn to obliques. The photographs taken in the air are taken from unknown points, and the first thing to do is to determine the position of the camera at the instant of exposure. The geometry of the method is none too strong, anyhow, and we could not expect to find the resulting place of the aeroplane with anything like the accuracy of a ground station. This leads me to think that stereographic survey from ground stations will be found to play an indispensable part in the future survey of mountainous country.

Suppose, for example, that political difficulties did not exist, and that we were able to survey the country south of Mount Everest. I think I would rather start out with a series of camera stations along the Singalela ridge, and fix all the visible crests stereographically with horizontal axes and vertical plates. A large part of the ground would be dead ground; but quite a good deal could be put in. Would this not solve the question of providing a fixed framework for the obliques from the air, perhaps combining each with a plate from a ground station, rather than in pairs of obliques? It will at any rate be worth the trial; and therefore I am anxious that we should not fail to exploit the relatively easy and inexpensive ground stations, while we are perfecting the vastly more difficult process of the oblique air photograph.

I suppose there never was a time when it was more difficult than now to forecast the future in surveying. We have seen already that geodesy is in a state of flux; we are not even allowed to believe that the pole or the continents stand fast in their right places. The methods that were canonical in field astronomy a few years ago are being rapidly displaced by new. The prismatic astrolabe is threatening to oust the theodolite; and Mr. Reeves has retaliated by inventing a small attachment to the theodolite that does the work of the astrolabe to perfection, and makes a separate instrument unnecessary. Sound-ranging and flash-spotting may yet be turned to the arts of peace, and there is something suspiciously like the latter in the

method proposed for connecting Egypt with Crete or Alaska with Siberia. Sound-ranging in air is perhaps not so likely to be useful to geographers as sound-ranging in water. But there is a post-War invention the future of which is brilliant. Who would have dreamed in the *Challenger* that her modern counterpart, the Royal Research Ship *Discovery*, would be equipped with deep-sounding gear on the method of echoes, that takes soundings in no time, or very nearly? It has become suddenly vastly more simple to measure the depth of the sea than the height of the land. There is much more sea than land, and a disproportionate part of it is very deep. Yet now for the first time we can begin to think of ocean contours drawn less by imagination and more by soundings in the new sense of the word.

If there was twenty years ago one branch of cartography that seemed stereotyped and unlikely to develop, it was surely the subject of map projections—a subject with a large and rather unprofitable literature; a science in which pure mathematics disported itself to the little advantage of maps; a science with a misleading title, since scarcely more than one of the useful projections is really a projection at all, the rest being only constructions; a science in which guiding principles were hard to find.

But in recent years the subject has taken on a new aspect. Tissot, and Jordan, and especially A. E. Young, have developed the expressions in infinite series—a process which sounds terrifying to those whose intelligences automatically shut up when they scent mathematics, but it is really an enormous simplification, because it reveals at once how much alike all these projections are in the first few terms, and precisely by how much they begin to diverge from one another when the sheet is extended. Moreover, this way of dealing with the subject allows the conscientious cartographer to distribute the errors judiciously by a process of cooking the projection, producing a flavour much appreciated by the connoisseur, though a taste not yet acquired by the common map-maker. But these refinements must not be looked at askance, as over-elaboration tending to preciosity. They have real practical advantages in the computing office.

This branch of our venerable science is therefore very much alive. It has even produced of late two new families—the retro-azimuthal projections which are the offspring of the Survey of Egypt, and the doubly-zenithal the father of which is Sir Charles Close. The former guides the Muslim in his prostration towards Mecca; the latter serves wireless direction-finding and other devices of the twentieth century. Could a student desire a subject of wider scope in which to exercise his powers?

The thought of the very charming modification of the polyconic projection devised by M. Charles Lallemand for the International Map on the scale of one in a million, leads us naturally to consider the outcome of that ambitious programme which was launched at the London Conference of 1909. Difficult as it was to secure enthusiastic co-operation before 1914 in producing sheets the marginal lines of which were necessarily drawn on a hard geometrical convention regardless of frontiers, it is trebly difficult now.

But I think it is fair to inquire if the original scheme was sound. There is an old proverb that if you want

a thing well done you must do it yourself, and with suitable modification this seems to me to apply especially to map-making. It is difficult enough for a single office to produce at intervals sheets that will absolutely match their neighbours. To expect uniformity from twenty or thirty reproduction offices is to expect altogether too much. One might indeed overlook slight differences in layer tints if one could only get the maps; but that is just the difficulty. Some countries are keen to meet their obligations, and some are not. India has produced a fine block of sheets; the North American Continent—I will not particularise—has produced three. I think we should find if we took a census that the majority of the Powers represented at Paris in 1913 have produced none, and show few signs of doing so.

With some trepidation I suggest, therefore, that the scheme for an International Map was bound to fail, because it required that each of many different countries should do its share, after a preliminary wrangle with its neighbours as to what that share was. Successful international co-operations have never worked that way. What has been the guiding principle of the successful enterprises? Surely that the reputed cost should be contributed by the nations in rough proportion to their populations, and that the work should be done by one. The Bureau International des Poids et Mesures, the old International Geodetic Association's Institute, the modern Bureau International de l'Heure, all these work or worked on that plan, with great success. The contributing nations get a great deal for a very small payment, and the nation which has the energy to take on the responsibility, and gets the credit, naturally contributes from its own resources, directly or indirectly, a large and essential part of the total cost.

The Survey of India has set us an admirable example in its map of India and Adjacent Countries, with a liberal interpretation of what adjacent means. Is it beyond hope that even in these hard times the Geographical Section of the General Staff might be given means to produce a map of the "British Empire and Adjacent Countries"—again without too much regard to the niceties of language?

Such a map of the world is indeed an almost necessary outcome of the P.C.G.N.'s work on names for British official use, for if unity of style could be achieved by miracle in an international map, there is no hope whatever for unity of spelling, or even of nomenclature. A sheet bears inevitably in its methods of transliteration the mark of its origin. We are all agreed that names in countries using the Roman alphabet should be spelled as in that country; the difficulty comes in transliteration from the non-Roman, and in descriptive names. The International Hydrographic Bureau at Monaco seems to me to have entered on a hopeless quest when it tries to obtain international agreement for the names of international waters. The French must surely always call Pas de Calais and La Manche what we call the Straits of Dover and the English Channel. The Germans will doubtless continue to speak of the Ost See, even though the bishop's wife protested to Elizabeth in Rügen that "the Baltic exactly describes it." Much can be done, no doubt, to eliminate superfluous variants and modern corruptions; but I do believe that the names for "British Official Use" must always

have a certain British flavour, however much we try to be scrupulous or even pedantic.

It will be agreed, I trust, that the science of map-making is healthily active and growing. Let us turn now to the art, which is twofold: the art of the convention by which the outline and the relief are reduced to the compilation, and the personal art of drawing the detail, the lettering, the divided margins, the ornaments, so that the finished map shall be clear, harmonious, and beautiful.

During the last thirty years we have seen the convention profoundly modified by the rapid improvement of colour lithography. Colour has, it is true, been used on engraved maps from the very first, and in my opinion the most agreeably coloured atlas ever published was the Rome edition of Ptolemy of 1486. But this was hand colouring, and no two copies are alike. In the years that followed the colour became more elaborate, but it was largely in the ornament, and the essential outline of the map was in black, from the single engraved plate. The great extension of possibilities came with the quite modern use of colour to distinguish the outlines of different classes: blue for rivers, brown for contours, red for roads, and so on. The enormous resulting improvement was conspicuously in the re-

presentation of relief. Layer colouring in particular, first employed on a large scale by the celebrated firm of Bartholomew, has given our maps all the advantages of a relief model without the inconveniences. It is a method in which the British have always excelled; and the supreme example of skill in layer colour-printing is the "Gamme" or colour scale attached to the report of the Paris Conference of the 1/Million Map in 1913: a scale which we may be proud to think was printed in England, at the War Office. There are infinite possibilities in the combination of layer colouring with contours, hachure, vertical and oblique hill shading; many of them have already been realised by the Ordnance Survey, particularly in their special maps of holiday districts, and in a map of South Devon which I regretfully remember in proof only, because it was found too expensive for issue. For we must note that a modern map passes through the press eight or ten or twelve times, and the cost of the machine work, apart from all the plates, is multiplied in the same ratio. The wonder is not that maps are expensive, but that in the circumstances they are so cheap. We should wish to believe, however, that the progress of invention may some day give us back that richness of tone that distinguishes the old engraved maps.

Obituary.

MR. J. Y. BUCHANAN, F.R.S.

THE last member of the original scientific staff of H.M.S. *Challenger* on her famous voyage of discovery in the great oceans has passed away by the death, on October 16, at eighty-one years of age, of Mr. John Young Buchanan. He holds an assured place as one of the founders of modern oceanography, and if his personal share in the fundamental researches is not more conspicuous in the text-books, it is largely because of his loyalty to the spirit of the expedition which gave the glory to the *Challenger* group rather than to individuals. He was in the most literal sense an original worker, always preferring to settle a point by observation or experiment rather than by books, and when reference to recorded work was necessary, always going direct to the fountain-head, never to a compilation. He paid no regard to authority or scientific orthodoxy, and did not get on comfortably with those who did. Censorship of research, even the reference to experts of papers submitted to a learned society, was obnoxious to him, and he spoke very plainly on this subject in communications to NATURE and elsewhere. So far as he allowed his singularly restrained and reserved nature to express itself in warm terms, he showed a passion for the freedom of research. He said: "To standardise research is to limit its freedom and to impede discovery. Originality and independence are the characteristics of genuine research, and it is stultified by the acceptance of standards and by the recognition of authority" (Preface to his "Comptes Rendus," 1917).

Buchanan was born in Glasgow in 1844, the second son of Mr. John Buchanan of Dowanhill, and was educated at the High School and University of his native city, where he graduated as M.A. Having decided to follow chemistry as a profession, he proceeded to study on the Continent, where he spent some time at the Uni-

versities of Marburg, Bonn, and Leipzig, and under Wurtz in Paris. On returning to Scotland he acted for a short time as assistant to Prof. Crum Brown in the University of Edinburgh. His leaning was always towards practical work rather than theoretical study, and he had little liking for teaching or lecturing. He excelled in manipulation, and especially in glass-blowing, a fact which weighed in his appointment as chemist and physicist on the *Challenger* expedition, where it was desirable that a scientific man should be able to make his own apparatus in case of need. The voyage of the *Challenger* lasted from December 1872 to May 1876, and most of Buchanan's time was occupied by routine work in measuring density of sea-water, collecting gas contents, and making qualitative analysis of all manner of natural deposits. He found time for several pieces of research which he afterwards developed in the private laboratory which his ample means allowed him to maintain, first in Edinburgh and latterly in London. The most important of these involved the thermal relations of sea-water and of salt-solutions generally, especially with regard to the formation of ice and steam.

A picturesque incident in the *Challenger* was his determination of the true nature of *Bathynus Hæckeli*, which Huxley believed from microscopic examination of preserved deposits to be a primitive organism covering the bottom of the sea. Buchanan proved it to be a gelatinous precipitate of calcium sulphate thrown down by alcohol, a fact which was very reluctantly accepted by the biologists on board, who were unwilling to think that Huxley, the highest authority, could possibly have made a mistake. Huxley himself at once accepted the correction in the frankest manner. A less dramatic but more constructive piece of work was the analysis of deep-sea deposits, especially of the red clay and the nodules of manganese peroxide embedded in it, on

which Sir John Murray based his theory of the formation of oceanic deposits and coral islands. Buchanan championed the hydrometer against chlorine titration as the measure of salinity, and he held to this view, although later work has convinced the oceanographers of to-day of the superior accuracy and convenience of the titration method. He made important experiments on the compressibility of substances at pressures existing in the depths of the sea, and the water and mercury piezometers which he made on board the *Challenger* yielded remarkable results in his hands, enabling him to measure depths and bottom temperatures irrespective of the length of line paid out. He pursued these investigations in later years, and read several papers to the Royal Society and the Royal Society of Edinburgh on the compressibility of solids.

The researches on sea-water initiated from the chemical or physical side were continued with the object of studying the conditions and movements of water in the sea and in lakes, thus leading their author from chemistry into physical geography. Buchanan made many scientific cruises in his steam-yacht *Mallard* on the west coast of Scotland and the lochs connected by the Caledonian Canal. Later he made a series of voyages on the cable-laying ships of the Silvertown Company along the west coast of Africa, and during the later years of his active life he was closely associated with the oceanographical researches of Prince Albert I. of Monaco. The Prince had a very great regard for him and consulted him in all details of his work on board the *Princesse Alice*, as well as in the organisation of the Monaco Oceanographical Museum and of the Oceanographical Institute in Paris.

During the 'eighties of last century the *Challenger* Office made Edinburgh a focus of activity in all branches of science, and Buchanan took his share in the intellectual revival, doing much to infuse new life into the flagging University Chemical Society, which he invited to hold its meetings in his laboratory. He helped in founding the Ben Nevis Observatory, and joined the Council of the Scottish Geographical Society soon after its formation. Above all, he furthered the work of the Scottish Marine Station which was opened at Granton in 1884. He fitted up his old chemical bench from the *Challenger* on board the floating laboratory *The Ark*, and when I was appointed chemist and physicist at the Granton station he proved a most helpful and kindly instructor. He was an exceptionally tidy worker, and planned a system of laboratory books for recording all observations, experiments and calculations, with scrupulous regard to dates and hours.

In 1889 Buchanan was appointed lecturer on geography in the University of Cambridge, and although he only occupied the position for four years, he found the social life of Cambridge so congenial that for twenty years he made Christ's College his home. This was probably the happiest period of his life, and he revealed more of his inner self in intercourse with his friends in the Combination Room than he was wont to do elsewhere. The coldness of his manner was probably due in part to shyness, in part to an extreme sensitiveness to the opinions of others, which he concealed by an assumption of indifference. He was never idle, and accumulated a mass of recorded observations, only a fraction of which was ever brought into shape for publication.

He had no freedom in writing, but he took immense pains to verify every statement and to make his meaning perfectly clear. His chief pleasure was in travelling, and he was an insatiate observer of things and men in all parts of the world. He had friends in every country in Europe, and was greatly affected by the outbreak of the War, during the course of which he resided in America and the West Indies.

Had Buchanan been a poor man, or bound to some permanent scientific position, he would probably have cut a deeper niche for himself in the Hall of Memory. As it is, he left no formal book behind him, though he long cherished the idea of producing a treatise on oceanography. After returning to England, he collected his more important and some of his slighter published papers in three volumes, which were brought out by the Cambridge University Press under the respective titles "*Scientific Papers, Vol. I.*" 1913, "*Comptes Rendus of Observation and Reasoning*," 1917, and "*Accounts Rendered of Work done and Things Seen*," 1919. In the remarkable synoptical tables of contents prefixed to these volumes, he gives notes and criticisms which throw an interesting light on his methods of work and modes of thought.

HUGH ROBERT MILL.

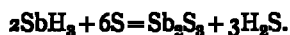
MR FRANCIS JONES.

AMONG chemists the name of Francis Jones is always associated—almost identified—with boron hydride. When Humphry Davy in 1809 heated the amorphous boron he had isolated with metallic potassium, and treated the grey mass with water, he found the hydrogen gas given off had a peculiar smell and took up more oxygen on explosion than did pure hydrogen. This observation was for seventy years the chief evidence of the existence of a hydride of boron, and after the researches of Wohler and Deville, who doubted its existence, chemical text-books and dictionaries maintained a strict silence on the subject. The discovery of the spontaneously inflammable silicon hydride by Buff and Wohler in 1857 left boron the one exception to the rule that all the non-metallic elements combined with hydrogen, and the methods adopted by these chemists—as well as the experience he himself had gained in determining the composition of the hydride of antimony—led Francis Jones to plan his research on boron.

Born in Edinburgh in 1845 and educated at the Edinburgh Institute and University, Jones decided at an early age to take up chemistry as a career and proceeded to Heidelberg to work in Bunsen's laboratory. It was his work here that led to his introduction to Roscoe, who brought him to Manchester in 1866 as research-assistant in his private laboratory. The years ahead were strenuous with Roscoe's great work on vanadium, whereby this element was first placed in its true order: and the young assistant could have had no better training-ground in chemical method or in manipulation. Four years later he was appointed demonstrator, and after two years' teaching at the Owens College, was chosen by the high master of the Manchester Grammar School to fill the place left vacant by Dr. Marshall Watts. His science work at the school soon won for it an almost unchallenged

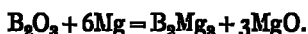
position among the large schools of England: the writer remembers well the succession of brilliant candidates he sent up for the Brackenbury science scholarships at Balliol between 1879 and 1886. For forty-seven years he continued to direct the chemical laboratories and to take his full share of teaching in the school.

Francis Jones must be placed in that small class of science masters who, in spite of incessant calls on their time and energy, have advanced chemistry in England. His first important paper on the properties and composition of stibine appeared in 1876 (*J. Chem. Soc.*). The composition of the hydride of antimony had previously been based on the analysis of the black compound thrown down when the gas mixed with hydrogen was passed through silver nitrate solution—presumed to be pure SbAg_3 . But metallic silver is also deposited in this reaction, and the substance is really a mixture, as Jones showed by his analyses. His next attempts were to measure the increase in volume when 2 litres of the hydrogen and stibine were sparked, but the proportion of the stibine was too small to enable its composition to be determined from the increase in volume and the weight of antimony formed. He discovered, however, that stibine was decomposed by sulphur at ordinary temperatures in bright light:



By passing the mixed gases through weighed sulphur-tubes and absorbing the hydrogen sulphide, he showed that one atom of antimony was combined with three of hydrogen. The orange colour imparted by stibine to sulphur gives us a very delicate test for antimony.

In 1879 appeared the preliminary note on boron hydride. In his first experiments Jones attempted to make magnesium boride by the action of sodium on a mixture of magnesium chloride and potassium borofluoride—following the method for making silicon hydride. The reaction was violent, but no hydride resulted from acidifying the product. Then he tried with success the direct heating of magnesium powder with boron trioxide:



When hydrochloric acid was dropped on to the grey friable product a gas was evolved which burnt with a bright green flame and had a most disagreeable odour. He had obtained the hydride mixed with hydrogen.

Two years later a fuller paper was published (*J. Chem. Soc.*, 1891) by Francis Jones and R. L. Taylor. Other methods of preparing the hydride were given, but the simplest was that described above—which always contained a large excess of hydrogen. The hydride was decomposed by passage through a red-hot tube leaving a brown deposit of boron; when bubbled through silver nitrate it formed a black precipitate containing silver and boron. Combustion of the mixed gases by means of copper oxide showed the hydride molecule to contain more hydrogen than the molecule H_3B , and to approximate to H_4B . Twenty years later, Ramsay, by cooling the mixed gas with liquid air, extracted another hydride from it, to which he assigned the formula B_2H_6 .

In 1884 Francis Jones published a simple method for detecting a chloride, bromide, and iodide when the

three salts are mixed together. By the addition of dilute sulphuric acid drop by drop to the salts in the presence of manganese dioxide and water the iodine can be boiled-off, then the bromine, the residue with strong sulphuric giving the chlorine. His other published work dealt chiefly with the effect of different modes of heating and lighting on the air of living-rooms: he took an active interest in the crusade against air pollution.

For many years he acted on the council of the Manchester Literary and Philosophical Society, and was president for the two years 1909-11: he gave his services freely to the last, and his kindly and sage counsel was always appreciated. H. B. D.

MR. G. L. SMITH, who died at Chertsey on September 25, was head of the Instrument Research and Design Department of the Royal Aircraft Establishment. As such he was responsible for a large number of instruments used on aircraft. His remarkable genius for this type of work enabled him to accomplish much work of great importance, though his share in it is little known outside the circle of a few associates. Born at Aberdeen about 1870, Mr. Smith followed a number of scientific pursuits—among which may be mentioned the design and application of the aero fire alarm, which was extensively used in England and the United States. At the outbreak of the War, he offered his services to the Royal Aircraft Establishment, where he remained until illness compelled him to resign a few months before his death. While of a somewhat retiring and unobtrusive disposition, his kindly and sympathetic nature made him beloved and respected by every one.

G. M. B. D.

WE regret to announce the following deaths:

Dr. E. J. Babcock, professor of industrial chemistry, metallurgy and mining and dean of the College of Mining Engineering in the University of North Dakota, on September 3, aged sixty years.

Dr. H. R. Carter, assistant surgeon-general of the United States Public Health Service and a distinguished authority on yellow fever and malaria, on September 14, aged seventy-three years.

Prof. T. Case, formerly president of Corpus Christi College and Waynflete professor of moral and metaphysical philosophy in the University of Oxford, on October 31, aged eighty-one years.

Dr. Paul Héger, honorary professor of physiology in the Faculty of Medicine at the University of Brussels, aged seventy-nine years.

Dr. J. R. Henderson, C.I.E., formerly professor of zoology in Madras Christian College, and Superintendent of the Government Museum and Aquarium in Madras, on October 26, aged sixty-two years.

Prof. J. N. Langley, F.R.S., professor of physiology since 1903 in the University of Cambridge, on November 5, aged seventy-three years.

Prof. J. Massart, professor of botany in the University of Brussels, corresponding member of the Paris Academy of Sciences and foreign associate of the Royal Academy of the Lincei, aged sixty years.

Rev. E. F. Russell, of St. Alban's, Holborn, one of Huxley's early students, who contributed to our issue of May 9, p. 751, his recollections of Huxley and of the course of biology being given in 1875 at South Kensington, on November 7, aged eighty-two years.

Current Topics and Events.

His Majesty the King has approved of the following awards this year by the president and council of the Royal Society:—A Royal Medal to Prof. W. H. Perkin, for his work on the constitution of the alkaloids; a Royal Medal to Prof. A. C. Seward, for his researches on the palæobotany of Gondwanaland. The following awards have also been made by the president and council:—The Copley Medal to Prof. A. Einstein, for his theory of relativity and his contributions to the quantum theory; the Davy Medal to Sir James Irvine, for his work on the constitution of the sugars; the Sylvester Medal to Prof. A. N. Whitehead, for his researches on the foundations of mathematics; the Hughes Medal to Mr. F. E. Smith, for his determination of fundamental electrical units and for researches in technical electricity.

THE following is a list of those recommended by the president and council of the Royal Society for election to the council at the anniversary meeting on November 30:—*President*, Sir Ernest Rutherford; *Treasurer*, Sir David Prain; *Secretaries*, Mr. J. H. Jeans and Dr. H. H. Dale; *Foreign Secretary*, Sir Richard Glazebrook; *Other Members of Council*, Prof. J. H. Ashworth, Prof. L. Bairstow, Prof. F. O. Bower, Prof. S. Chapman, Sir Dugald Clerk, Prof. F. G. Donnan, Prof. E. J. Garwood, Prof. J. P. Hill, Prof. J. B. Leathes, Prof. J. C. G. Ledingham, Sir Thomas Lewis, Prof. F. A. Lindemann, Sir Robert Robertson, Sir Charles Sherrington, Dr. G. C. Simpson, and Mr. W. C. D. Whetham.

SIR ERNEST RUTHERFORD, O.M., who has been nominated to succeed Sir Charles Sherrington as president of the Royal Society, was born at Nelson, New Zealand, on August 30, 1871. Educated at Nelson College and Canterbury College, New Zealand, he proceeded to the University of Cambridge, entering Trinity College. He occupied the post of Macdonald professor of physics, McGill College, Montreal, from 1898 until 1907, when he left to become Director of the Physical Laboratories in the University of Manchester. From thence he went to Cambridge to take up the duties of Cavendish professor of physics, a post which he still occupies and adorns. Nobel Laureate in chemistry in 1908, Sir Ernest was Copley medallist of the Royal Society in 1922. In 1923 he was president of the British Association at its Liverpool meeting, and he remarked that it was in Liverpool in 1896 that he first attended any gathering of the kind, and that there he read his initial scientific paper. Sir Ernest's address was entitled "The Electrical Structure of Matter." The unknown appears, he said, as a dense mist before the eyes of man. In penetrating the obscurity we cannot invoke the aid of supermen, but must depend on the combined efforts of a number of adequately trained ordinary men of scientific imagination. It may be recalled that Sir Ernest Rutherford was the recipient, in 1908, of the Bressa quadrennial prize of 9600 lire (say 400*l.*) at the disposal of the Turin Academy of Sciences, instituted to recompense the most notable scientific achievement during the

particular period. We believe that no other Englishman has received this award.

DR. HENRY H. DALE, C.B.E., who has been nominated for the secretaryship of the Royal Society in succession to Sir William Hardy, is a Londoner, and was born in 1875. Educated at Tollington Park School and the Leys School, Cambridge, he graduated at Trinity College, Cambridge, taking up afterwards his medical career at St. Bartholomew's Hospital, London. At the present time Dr. Dale is head of the Department of Biochemistry and Pharmacology under the Medical Research Council. He gave a series of lectures in Johns Hopkins University, Baltimore, in 1919. Croonian lecturer at the Royal Society in 1919, he was last year awarded a Royal Medal of the Society in recognition of his researches in pharmacology and physiology.

MR. BALDWIN, Prime Minister, in his Rectorial address to the students of the University of Edinburgh on November 6, made a comparison between the aims of university study and the practice of politics. The student learns to acquire "habits of accuracy in measurement, precision in statement, honesty in handling statement, fairness in presenting a cause—in a word, to be true in word and deed." The politician, on the other hand, is concerned with persuading people to support his cause, so that truthfulness has often to be sacrificed to expediency. The result "is inevitably to place a veto on complete frankness, and to tempt recourse to words which are nebulous, hesitating, ambiguous, or misleading." While the discovery of truth is the purpose of scientific investigation, in the political field the truth may be tempered to the minds of an audience if a favourable impression is thereby secured. Mr. Baldwin did not for a moment suggest that such methods of political sophistry were worthy of an educated people, but he excused them as a consequence of a democratic constitution, and he urged that it was the business of universities to change the conditions which enable a modern demagogue to mislead the public. It will be a long time before the voters who decide how the State shall be governed will be able to distinguish between the special pleading of an advocate and the summing up of a judge when political questions are under discussion, and meanwhile they have the power to decide matters upon which they have no actual knowledge. The duty of those who object to this penalty of democratic control is to take an active part in enlightening the public and in securing the entrance into Parliament of members who not only know how to search for truth but also how to use scientific methods in its application to social life.

THE disaster in the valley of the Conway in North Wales on the night of November 2 adds another to the melancholy list of failures of dams, or retaining embankments, which have been constructed to the best of human knowledge and ability, and yet have developed some unsuspected source of weakness

resulting in collapse, unfortunately attended in so many cases by sad loss of human life and much destruction of property. The dam at Llyn Eigiau, North Wales, was constructed in 1908 for the purpose of impounding water to supply hydro-electric power for the aluminium works at Dolgarrog. It is a concrete embankment, shaped in plan like the letter L, with the angle, which, in reality, is slightly curved, jutting into the lake. The enclosure is estimated to have contained, before the collapse, about one thousand million gallons of water. A breach, which occurred near the junction of the two arms of the dam, apparently below the concrete work, allowed the whole or greater part of this mass of water to escape. For a distance of more than two miles, it traversed the relatively level bed of the stream which carries the normal overflow, and then precipitated itself down the mountain side in an almost perpendicular descent of nearly 1000 feet into the Conway valley below. Great boulders of rock, blocks of concrete, a girder bridge, a temporary iron church and a number of buildings were swept away and piled into a mass of debris and ruin along its course. The disaster is said to be the greatest of its kind which has occurred in Great Britain since the catastrophe at Bradfield, near Sheffield, more than sixty years ago, though more notable and devastating failures have been recorded in other countries.

COMMENTING ON OUR note (NATURE, October 24, p. 620) concerning his recent article on the position of the classics, Prof. J. P. Postgate writes that although it was not unfair to mention that the committee of the British Association had unanimously rejected the claims of Latin to be chosen as the international auxiliary language, it must not be forgotten that the committee, with one dissentient, also rejected the claims of English; and that although reporting in favour of the adoption of an artificial language, namely, Esperanto or Ido, the committee was unable to decide between them. "Their conclusion, then," he says, "was a purely negative one, and in present circumstances it could hardly have been otherwise." We thank Prof. Postgate for reminding us of the further decisions of this committee, but we cannot agree with him that the recommendation of Esperanto or Ido was a "purely negative" conclusion. Esperanto, in particular, is showing much vitality as an auxiliary language, "a special tool for a special purpose"; and we do not think that the position of the classics as a means of culture would in any way suffer if an easier, synthetic language were adopted for scientific and commercial purposes, or even as the medium for the exchange of international thought generally. Did not Mr John Galsworthy declare recently that such exchange was the only possible salvation of the world?

THE work of M. Léon Guillet is well known to British metallurgists as well as to his compatriots, and many will be interested to know that his recent election to the Paris Academy of Sciences has been made the occasion of a proposal to raise a fund for a testimonial to M. Guillet, in recognition of the services

rendered by him to education, science, and industry. His work has covered a wide range, but his name is best known in connexion with researches on the alloy steels and on bronzes and other alloys of copper, particularly in regard to the changes brought about in them by quenching and other forms of heat treatment. A circular containing an appeal for subscriptions for this purpose has been issued, and is signed by many metallurgists, England, Belgium, Sweden, Italy, Denmark, and the United States being represented as well as France. Subscriptions should be sent to M. Roszak, 8 Rue Jean-Goujon, Paris VIII^e.

IT is a gratifying indication of the position of scientific metallurgy in Great Britain that the two principal metallurgical societies, the Iron and Steel Institute and the Institute of Metals, have practically become international organisations, numbering a large foreign membership, and serving as the medium of publication for a mass of important work from foreign countries. We have received from the Institute of Metals a booklet addressed to metallurgists in the United States, containing a list of the two hundred members of the Institute resident in that country, and giving particulars of its activities. Recent volumes of the Journal of the Institute have contained many important papers from foreign sources, whilst its abstracts are much more complete than anything published elsewhere. There are obviously great advantages in a common medium of publication and a common source of reference to metallurgical literature, serving the whole of the metallurgical world acquainted with the English language, and the growth of American membership is a healthy sign.

IN the *Forum* for September several articles deal with China. Of these the more important are "China in Ferment," by Walter Littlefield, an attempt to analyse the present political situation in its bearing upon the covenants of Washington of 1921-1922, and "The Foreign Devil in Young China," by John Brailsford, in which the author seeks to define the relation of western industrialism and western revolutionary thought in China. Neither writer offers much ground for optimism. The former, while crediting Washington with sincerity in forming the covenants through which China was to preserve her territorial and political entity, considers that both China and the other Powers signatory to the convention who are interested in the exploiting of China have proved indifferent to Washington's solicitude. The author fails to see that his naive conclusion that not only is it difficult to gauge the real attitude of the individual Manchus but also that any one of these who may hold Peking is prepared to assent to measures which he is unable to guarantee will be carried out, and his still more naive confession that Washington does not appear to have grasped this fact, are not only a criticism of the United States diplomacy, but also an endorsement of the attitude of Great Britain that China must first place her house in order before anything can be done in regard to treaty rights. Of this attitude he is both critical and suspicious. In

the second article, Mr. Brailsford shows that the intellectuals and students, whether Christian or heathen, have eagerly embraced revolutionary ideas out of sympathy with labour in opposition to western industrialism. They favour, on the whole, a class struggle rather than peaceful reform by development of the Chinese guild and social systems. As the adverse conditions of western industrialism have had as yet little or no opportunity to develop in China, the revolutionary attitude seems unreal and doctrinaire as well as misdirected. The need for political and administrative reform is real enough.

MR. R. A. CHATTOCK, the electrical engineer to the City of Birmingham, gave a short but interesting presidential address to the Institution of Electrical Engineers on October 22. He pointed out that the new processes being introduced for the production of steam enable us to obtain more perfect combustion and higher temperatures. The difficulties with regard to furnace linings have been overcome by screening the furnace walls with water tubes which form part of the boiler itself. He then pointed out some of the advantages of pulverised fuel. He reminded his hearers that if the distillation of coal proves to be commercially feasible, from 30 to 70 per cent more weight of coal will have to be handled so as to get a given electrical output. Hence although in some cases it will be profitable to adopt this process, the number of pounds of coal for a given output will compare very unfavourably with that required by a station burning coal to destruction. There is also, as in the case of the gas industry at the present time, a serious financial risk of finding it impossible to dispose of the by-products at a remunerative price. Mr. Chattock laid stress on the importance to a power station of having the ratio of the average output to the total output, that is, the load factor, as large as possible. A residential neighbourhood has only a power factor of about 10 per cent. If prices to the consumer are to be reduced, it is necessary to foster the use of electricity for heating and cooking by an attractive two-price tariff. He is opposed to the political agitation for constructing a few large power stations and distributing over considerable distances to many substations. In his opinion the cost of distribution would in general be so great that no appreciable reduction in the price would be possible. It will be remembered, however, that the main reason for Mr. Snowden making the suggestion in 1924 was that it would reduce the number of unemployed. Mr. Chattock is also strongly opposed to having a single standard frequency for alternating current supply. He pointed out the great convenience of having mercury arc rectifiers in order to convert alternating to direct current supply. Most engineers are in favour of standardisation, but if it be adopted too soon, it will only hamper progress.

On Saturday, November 7, the Marchese de Pinedo landed at Rome, after having completed a flight in a Savoia 16 flying boat of about 35,000 miles to Australia and Japan and back again. This remarkable journey commenced on April 21 last, and the route followed was via Baghdad, India, Burma, Singapore, and the

Dutch East Indies, to Australia. Leaving Australia and turning north, Japan was reached, and here a new engine was fixed. Thus some 20,000 miles were covered by the first engine, and the second sufficed to bring the seaplane home via the coast of China to Burma, and then along the usual airway to Europe. Throughout the journey, which took 370 flying hours, the Marchese de Pinedo was accompanied only by one mechanic. The achievement was noteworthy as regards both the skill and endurance shown by the airmen and the general trustworthiness for transcontinental and transoceanic travel which the seaplane has shown itself to possess.

THE hundredth annual course of Christmas Lectures for juveniles at the Royal Institution will be delivered this year by Sir William Bragg on "Old Trades and New Knowledge." The trade of the sailor is the title of the first lecture, to be given on Tuesday, December 29, and the following five lectures will be on the trades of the smith, the weaver, the dyer, the potter and the miner.

THE president of the Executive Committee of the International Research Council has summoned a meeting of the General Assembly of that body to be held at Brussels on June 29, 1926. The object of the meeting will be to discuss the advisability of removing from the statutes the restrictions which have hitherto stood in the way of admitting the Central Powers of Europe to the Research Council.

APPLICATIONS for the Royal Society Government Grant for Scientific Investigations for 1926 must be received by, at latest, January 1 at the offices of the Royal Society, Burlington House, Piccadilly, W.1. They must be made on a printed form obtainable from the clerk to the Government Grant Committee, Royal Society.

AN informal lecture will be delivered before the Chemical Society at Burlington House on Thursday, November 26, by Prof. R. Robinson, professor of organic chemistry in the University of Manchester, who has chosen as his subject "Recent Researches on the Structural Relationships of some Plant Products." The lecture will be given at 6 o'clock, and not at 8 o'clock as originally announced.

THE first broadcasting station in the Irish Free State has been erected by Marconi's Wireless Telegraph Company, Ltd, in the McKee Barracks in the outskirts of Dublin. The studio will be in Denmark Street, off Henry Street. The transmitter, which will operate on a wave-length of 390 metres and will use the call sign 2RN, is a Marconi 6 kw. type Q set. This is the same type as that used at the majority of British broadcasting main stations, and also at a large number of foreign stations. It is expected that tests will begin shortly, and that the service will be inaugurated during December.

AN exhibit of winter-flowering begonias, showing the wild species from which these winter-flowering begonias have been derived, has been arranged at the Royal Botanic Gardens, Kew, in the house which is devoted to objects of special and current interest. The two wild species which are particularly

concerned are *Begonia socotrana*, from the Island of Socotra, and *Begonia Dregei*, from South Africa. *B. socotrana* was introduced in 1880 by the late Sir Isaac Bayley Balfour, Regius Keeper of the Royal Botanic Garden, Edinburgh. This, in itself a beautiful winter-flowering species, has proved of immense importance as the progenitor of our present-day race of winter-flowering Begonias. From 1883 onwards Messrs. J Veitch and Sons produced many fine winter-flowering varieties by inter-crossing it with various tuberous-rooted varieties of begonia from the Andes of South America. Some of the most recent hybrids resulting from these crosses are "Exquisite," "Fascination," and "Optima," which are shown in this group. The leaves tend to resemble those of the Andean species rather than those of *B. socotrana*. Though they are very beautiful plants, as can be seen from the display in the Kew Conservatory, they are not very generally grown as their cultivation presents some difficulties. M. Lemoine, of Nancy, in 1892 crossed *B. socotrana* with the South African species, *B. Dregei*. The resulting hybrid was *B. Gloire de Lorraine*, of which there are now several varieties, including some of American origin, such as "Glory of Cincinnati" and "Mrs. Petersen." These are now some of the most popular and easily grown plants for winter decoration. There are now four additional sets of picture postcards in colour on sale at the Royal Botanic Gardens. These comprise a set of stove and greenhouse plants, two series of rock garden and hardy herbaceous plants, and a set of Himalayan rhododendrons.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned.—A professor of materia medica at the Royal Veterinary College, Camden Town, N.W.1—The Secretary (November 21). A lecturer in the department of electrical engineering of Bradford Technical College—The Principal (November 24). The professorship of physics at University College, Nottingham—The Registrar (November 28). A county analyst under the Lancashire County Council—Clerk of the Lancashire County Council, County Offices, Preston (November 28). An assistant lecturer in mechanical engineering at the Manchester Municipal College of Technology—The Registrar (November 30). A lecturer in pathology and bacteriology in the Welsh National School of Medicine, Cardiff—The Secretary (December 4). An assistant lecturer in physics at Natal University College, Pietermaritzburg—The Registrar (December 31). A part-time assistant in the department of zoology and geology of University College, Southampton—Dr. W. Rae Sherriffs. A lecturer in education in the University College of Wales, Aberystwyth—The Secretary. A professor of biology and a professor of bio-chemistry in the College of Medicine, Singapore—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1. A laboratory assistant in the physics department of the Liverpool Collegiate School for Boys—Director of Education, 14 Sir Thomas Street, Liverpool. A male junior assistant in the Research Department, Woolwich, for computing work in connexion with ballistic observations—Chief Superintendent, Research Department, Woolwich.

Our Astronomical Column.

NOVEMBER METEORS.—Mr. W. F. Denning writes: "The return of these meteors is due on the mornings of November 15 and 16, but they are not expected to be unusually abundant. In certain years, however, when the display was not anticipated, it came with special activity.

The orbit of the stream extends out to beyond the path of Uranus, and the cometary system, to which it owes its parentage, has a period of about $33\frac{1}{2}$ years. All along this lengthy ellipse the meteoritic particles are distributed, and they are certainly clustered more abundantly in certain sections of the orbit than in others. Hence the annual displays vary in their character, some being much richer than others.

This year there will be no moonlight to interfere with observation. The radiant point does not rise until nearly 10.30 P.M., and the meteors cannot be seen before that time; in fact, the most promising period at which to watch for them lies between 1 and 5 in the morning. The splendid display of 1866 reached its maximum at about 1.10 A.M., when one observer counted about two hundred meteors per minute.

The meteors of this system are generally bright, very swift, and leave luminous trails which often linger for several seconds and, in the case of very bright objects, may endure for 10 or 15 minutes. The directions of the meteoric flights are from the well-known "sickle" of stars in the western part of Leo.

The comet associated with this shower was last

seen in 1866. It will return in 1933, and for several years before and after that time showers of these mid-November meteors should be as abundant as they are attractive.

Though one of the richer sections of the stream which gave us the display of 1866 was sufficiently disturbed by the attraction of Jupiter to enable it to pass outside the earth's orbit in about 1899, there are other regions of the system capable of inducing rich displays, as in 1867, 1868, and 1869. There were also fairly abundant exhibitions of meteors in 1901 and 1903."

THE MASSES AND COLOURS OF THE STARS.—*Astr. Nach.* No. 5394 contains two papers on these subjects by G. Shain and Miss V. Hase, of the Simeis Observatory, Crimea.

The former contains arguments favouring Eddington's masses, deduced on the assumption that absolute luminosity is a function of mass, rather than those of Seares, deduced from the principle of equipartition of energy (*i.e.* assuming that Mv^2 is constant for all stars). The latter principle is shown to fail for the brighter giant stars, notably those of type B, though for the dwarfs it agrees fairly with Eddington.

In the other paper it is argued that there is a correlation between colour and absolute magnitude, the giants of a given spectral class being redder than the dwarfs, and the dwarfs having the higher temperature for a given intensity of spectral lines.

Research Items.

THE ROYAL MAGICIAN IN ANCIENT EGYPT.—Attention has frequently been directed to parallels in the customs of the ancient Egyptians and of African races. Such a parallel has been suggested by Sir Flinders Petrie as an explanation of a frequent scene in the royal functions of ancient Egypt in which a king is seen rapidly striding or running and bearing certain objects. This performance has been termed by Hermann Kees *Opfertanz*; but, as Sir Flinders Petrie points out in *Ancient Egypt* for September, the action is that of running, not dancing. Nor is the purpose to sacrifice or make an offering. He suggests that these scenes represent a ceremony analogous to the rain-making ceremonies of the African chief. They are usually found at the ends of the lintels in great temples, but occasionally elsewhere. The general meaning is indicated by certain signs such as the three *adeb* signs signifying cultivated land, which connect the ceremony with the cultivated fields, a small female figure frequently accompanying the king, with the plant of Lower or Upper Egypt on her head, and inviting him to come and bring the inundation, and, frequently, a galloping bull representing the Nile. This invocation begins as early as the sixth dynasty. The origin of the ceremony is indicated by the flail which is shown. This appears to have been derived from the bull's tail, which was used as a fertilising lash before the artificial form took its place. Thus it appears that the king went round the fields ceremonially to drive away evil influences, fertilising them with the lash and leaving blessings behind him. Fans are also shown. These are divine symbols, and are the regular adjunct of African rulers down to the present day. Later ceremonies (eleventh dynasty) show the oar, and (eighteenth dynasty) two vases for pouring water in the hands of the king. It would therefore seem clear that Egypt had a king of that African type of which the principal function is to act as a magician who controls the rain. In Egypt, as there was no rain, it was his duty to bring the inundation which made fertile the cultivated lands.

FAMILY NAMES IN FRANCE.—Dr. Albert Dauzat in *La Nature* for October 3, discusses the origin of French family names. After the disappearance of the Roman system of nomenclature, surnames only reappear with the stabilising of the feudal system in the ninth and tenth centuries. Between the eleventh and fifteenth centuries the individual name is followed to an increasing degree by a surname which tends to become the family name by passing from father to son. This tendency is particularly apparent from the time of Philip Augustus, beginning in the south and spreading rapidly to the north and the Rhine area. With the establishment of registers in certain parishes at the end of the fifteenth century, these surnames began to be fixed. Jewish family names, however, were not legally established until 1808. French family names fall into four principal categories. First are individual names which have been perpetuated without modification, such as Henri, Louis, or with modification: Jacques, Jacoton, Cottin. Many are individual names no longer in use, mostly of Germanic origin, e.g. Aymon, Rambaud, Arnaud. These are also modified in various ways. A second category includes names derived from location or habitation (Caseneuve, Dubois, Delaval, Delarue) or origin (Le Breton, Paris, Le Normand, Langlais). Thirdly come names of profession or occupation—Chausseher, Feuvre, Fournier. The fourth class, which is very large, consists of soubriquets and includes

such names as Le Grand, Le Gros, Poincaré, Roussel, Rousseau, Bossu, Bossuet, Chappedelaune, Legendre, and the like. In addition to patronymics, a number of matronymics, such as Marguerite, Collette, and so on, also occur.

CLIMATE AND HUMAN ENERGY.—In an interesting analysis of the results of the Olympic Games of 1920 (Antwerp) and 1924 (Paris), which Dr. Guillermo Hoxmark, of the Weather Bureau, Buenos Aires, has published in *Ecology* (New York), vol. 6, No. 3, July 1925, success in the competition is correlated with mean temperature as a suggested index of the relation of energy and climate. This study follows the lines taken by Huntingdon and others in establishing zones of human energy and civilisation. Twenty-six countries were represented, and the number of inhabitants of each is here divided by the number of points gained, thus giving the number of thousands of inhabitants per point. The countries are then ranged in the resulting order. An index number is assigned to each, the smallest number of thousands per point being 100. When brought into relation with mean annual temperature, it appears that a low index number, i.e. high average athletic ability, and a low average temperature go together. The figures of the two competitions, taken separately and together, give approximately the same result. In each case, Norway, Finland, and Sweden head the list in the order named. Great Britain stands twelfth, Spain, Czecho-Slovakia, Japan and Egypt are among those at the bottom of the list.

WARM FEBRUARY OF 1925 IN THE UNITED STATES.—The *Monthly Weather Review* for May contains a discussion by Mr Alfred J. Henry which shows that February 1925 in the continental United States was the warmest February during the last forty years. No other February has averaged so much as 5° 8 F. above the normal for the country as a whole. The monthly departures ranged from a minimum of 1° 2 above the normal in the Florida peninsula to 10° 1 above in the region embraced by the States of Montana, Wyoming, and the western parts of South Dakota and Nebraska. An attempt is made to ascertain the cause of the temperature departure. Both primary and secondary cyclones lacked in intensity during the month, and naturally strong pressure gradients were absent. The anticyclones experienced were not associated with an indraught of cold air. A detailed examination was made by the author of the pressure conditions existing over the Pacific and elsewhere with the object of tracing, if possible, the relation between these varying conditions and the exceptionally warm weather experienced in the United States. The author concludes that the explanation of the warm weather experienced must be referred to the presence of an oceanic cyclone over the Gulf of Alaska which occasioned suitable atmospheric conditions for ill-defined cyclonic systems to be detached from the primary oceanic cyclone and to pass along the northern boundary towards the Atlantic, inducing on their fronts an unusual frequency of southerly winds. Attention is directed to the growing belief on the part of meteorologists that the cause of unusual seasonal variations is associated with conditions prevailing in the Arctic and Antarctic regions, and reference is made to the difficulties of verifying this supposition.

CARBONIFEROUS FOSSILS FROM CHITRAL.—Dr. F. R. Cowper Reed has completed the sixth volume of the new series of the *Palæontologia Indica* with a well-

illustrated memoir on the Upper Carboniferous fossils collected by the late Sir H. H. Hayden in Chitral and the Pamirs in 1914. Most exhaustive comparisons are made, and the fauna is shown to be distinct from any hitherto found in India or Kashmir. It is specially characterised by the abundance of the foraminifer *Fusulina*. The whole fauna resembles that found in the Upper Carboniferous of the Ural mountains, and it may be inferred that the late Carboniferous Eurasiatic Mediterranean Sea extended across Chitral into Turkestan and Central Asia.

MIOCENE ANTHRACOTHERES FROM BALUCHISTAN.—In 1909 and 1910 Mr C. Forster Cooper made an important collection of mammalian remains from a Lower Miocene deposit at Dera Bugti in Baluchistan. The specimens were prepared for study at the British Museum, where they are now preserved, and most of them have been described by Mr. Forster Cooper in a valuable series of papers and memoirs. The latest of these contributions is an exhaustive study of the primitive hoofed mammals known as Anthracotheriidae, published as a memoir in the *Palaeontologia Indica* (new series, vol. 8, No. 2). Most of the fossils representing this group are fragmentary jaws and teeth, but they suffice to indicate great diversity both in size and form. They make known a remarkable assemblage of mammals, all of one family, living side by side and presumably fighting together to some extent for the means of subsistence, some of them closely allied to one another and some evolving on marked lines of their own. They remind us of some of the assemblages of antelopes still or until recently existing in Africa.

RONTGEN RAYS AND PALÆONTOLOGY.—In the Geological Museum of the Russian Academy of Sciences, Drs. A. Hartmann-Weinberg and S. A. Reinberg have been experimenting on the detection, by means of X-rays, of fossils enclosed in pieces of rock, and they have just published their results in the *Bulletin of the Academy*. They have been especially successful in finding pieces of bone in sandstone, and a little less successful in detecting similar fossils in shale. They have used pieces of concretions containing reptilian bones collected by the late Prof. Amalitzky in the Permian sandstone of the Northern Dvina, and their radiograms of several specimens are sufficiently clear to guide the preparator in uncovering the various fragments. They have also been successful with an ammonite in sandstone. They find that, for the purpose, no piece of sandstone should be more than 30 to 40 cm. in thickness. The authors, however, point out that buried fossils can only be detected by X-rays when they differ considerably in constitution from the enclosing rock. Bones impregnated with calcite, for example, are not shown in the radiograms when the surrounding rock is limestone. The latter result accords with the experience of the British Museum when an attempt was made some years ago to examine the skeleton of *Archæopteryx* by the same method.

MOUNT LOGAN.—An account of the first ascent of Mount Logan, the loftiest summit in Canada, appears in the *Dominion Land Surveyors' Journal* for October. Mount Logan, which lies some forty miles to the north-east of Mount St. Elias, was photographed from the south by the Duke of the Abruzzi's expedition to Mount St. Elias in 1897, and its great height was not established until the survey of the Alaska-Yukon boundary in 1913. The ascent was made this year by a small party of Canadians under the leadership of Mr. A. H. MacCarthy, who was accompanied by Mr.

H. J. Lambert of the Geodetic Survey department. The climb was made from the west up the Ogilvie glacier and the King glacier. Above 14,500 ft. the reduced pressure hampered the climbers. Progress was very slow, and it was difficult to get a restful sleep. However, on June 23 the summit was reached at 19,850 ft. Mr. Lambert's article is illustrated with several photographs.

EARTHQUAKES IN THE UNITED STATES.—How numerous are the earthquakes in the United States is evident from a short article published in the *Volcano Letter* for September 17 of the Hawaiian Volcano Research Association. During the nine years 1915–23, the total number of earthquakes was 955, or more than a hundred a year, felt in as many as 42 States. Had the record been continued up to February 1925, every State would have been represented except Delaware, Florida, and Louisiana. The most frequently disturbed State is California, with 594 earthquakes. In the eastern States, the most active regions lie along the middle part of the Mississippi River, and it is noteworthy that some of the earthquakes there affected areas nearly as great as that disturbed by the San Francisco earthquake of 1906, though at the surface the damage caused was slight. This shows that the foci in the east of the country are more deeply-seated than those in the west. During the first part of the period considered, several earthquakes were experienced at or near Charleston, the scene of the great earthquake of 1886.

NEWER MAGNETIC PHENOMENA.—In the November issue of *Conquest*, Prof. J. A. Fleming gives a short account of some of the recent discoveries in magnetism. Many of them depend on the fact that iron can exist in two allotropic forms, α below 780°C , and γ above. The former is magnetic and the latter not. A steel containing 12 per cent. of manganese and a cast iron containing 6 per cent. of manganese and 9 per cent. of nickel are non-magnetic at low temperatures. On the other hand, iron alloyed with 78.5 per cent. of nickel is in weak fields more magnetisable than wrought iron, and Heusler's alloy, MnAlCu_2 , is as magnetisable as cast iron. The effects of alternating fields on feebly magnetic iron ores, discovered by Mr. Mordey and used for the separation of ores, are traced to the lag of the magnetisation behind the field as shown in the hysteresis curves.

THE ISOTOPE EFFECT IN THE SPECTRUM OF SILICON NITRIDE.—The spectrum of silicon nitride can be produced by introducing silicon chloride vapour into active nitrogen, and in the *Physical Review* for September, Dr. R. S. Mulliken describes the structure of the bands, in the fourth paper of a series dealing with the isotope effect in band spectra. The structure is of a simple type, resembling in some respects the spectrum of cyanogen (CN), and it is shown that the bands are due to a diatomic emitter, both the chemical evidence and the isotope effect indicating that this is SiN . A striking feature is the unusual prominence of the null line, or missing line, in each band; this is also the case in the cyanogen bands. Weak satellite band heads due to Si^{29}N , and slightly weaker ones due to Si^{30}N , accompany the stronger Si^{28}N bands, as reported by Mulliken in *NATURE*, March 22, 1924, p. 423, and in agreement with Aston's positive ray work on the isotopes of silicon. Equations have been worked out for the positions of the band heads and for the band structure; from these it is deduced that the distance between the atomic nuclei is 1.56×10^{-8} cm. in the vibrationless molecule. In a paper in the July number of the *Physical Review* the isotope effect in the

band spectra of copper iodide (CuI) is dealt with in detail, the spectra of copper fluoride, chloride and bromide having also been partially investigated. The effects of the two isotopes Cu^{63} and Cu^{65} are clearly shown in the spectra.

THE STRUCTURE AND DISTRIBUTION OF BAND SPECTRA.—In a series of papers in the *Comptes rendus Acad. Sci.*, Paris, ending with one on October 5, M. H. Deslandres puts forward the following formula for the distribution of the principal and secondary bands in the infra-red spectra of simple chemical structures:

$$\nu = qd_1/rs \pm q'd_1/r's',$$

where ν is the frequency, d_1 a universal constant or fundamental frequency = 1062.5 , s the number of atoms or of large rings of electrons in the molecule, s' the number of exterior electrons of an atom and q, r, q', r' whole numbers; r in the examples given in the paper of September 28, which relate to the first term, r *e. g.* to the principal bands, being 1, 2, 3, 4 and in some cases 6 for different bands. The second term in the equation represents the secondary bands which appear in the principal band with sufficient dispersion. The first term has been verified with twenty absorption spectra of substances of very simple structure. The author found in 1919, in 11 infra-red and 29 luminous or ultraviolet spectra, that the most intense band frequency is almost exactly a multiple of d_1 , which follows from the above formula in the case of the infra-red bands. The line spectra emitted by single atoms are connected with the constant d_1 by the same simple law. The author considers that the facts imply the existence of a new series of vibrations intimately connected with the fundamental frequency d_1 ; he supposes that they originate in the nucleus of the atom or in a "protective" sphere connected with the nucleus.

THEORY OF THE PHENOMENA AT THE CATHODE IN GLOW DISCHARGE.—A large amount of work has recently been carried out by Dr. A. Güntherschulze on the glow discharge, and in the *Zeitschrift für Physik* of August 31 he develops the theory of the phenomena observed at the cathode in terms of recent developments in the determination of the behaviour of electrons accelerated in an electric field through a gas at low pressure. He makes use of the results of Brose, who has determined the field intensity in the space between the edge of the negative glow and the cathode, the "fall space," in the case of the abnormal cathode fall; and assumes that the curve of field intensity has the same form in normal cathode fall. The dark space observed by Aston in the case of hydrogen and helium, between the cathode and the thin luminous layer of the cathode glow, is ascribed to the fact that here the electrons given out by the cathode have not acquired the velocity necessary for the excitation of the atoms. In the cathode glow the excitation velocity is reached, and the excited atoms give out light; but Seeliger has shown that when the velocity becomes still higher excitation diminishes, and this is why the Crookes space is nearly dark. Ionisation takes place here, free secondary electrons being split off from the atoms and positive ions being formed, which move towards the cathode, and colliding with it produce a further supply of electrons from its surface. The above secondary electrons are accelerated by the field in the Crookes space, and a large number of them reach excitation velocity at the edge of the negative glow, where the luminosity rises very quickly, falling off again farther on when, owing to the continued acceleration, the number of electrons with the exciting

velocity has diminished. A number of relations between the length of the fall space, the voltage drop in it, the current density and other variables are worked out.

THE POLARISATION OF THE ZODIACAL LIGHT.—Visual observations have given contradictory results as to the polarisation of the zodiacal light. M. J. Dufay has recently carried out a series of measurements photographically, using first a nicol prism and then a doubly refracting analyser, which gave two images of the opening in a diaphragm illuminated by a small region in the zodiacal light (*C. R. Acad. Sci.*, Paris, September 28). In this way it was possible to photograph simultaneously two components the vibrations of which were at right angles to one another, and to study the relative intensities with the microphotometer on the photographic plate. Thus the depolarisation, ρ , of the original light, that is, the ratio of the intensity i , of the beam the vibrations of which are in the plane passing through the line of sight and the sun, to that, I , of the beam the vibrations of which are perpendicular to this plane ($I > i$), can be determined, and from this the proportion, p , of the light which is polarised in the above plane. A number of measurements have been made of small regions near the plane of the ecliptic and distant from 30° to 95° from the sun; ρ appears to diminish from 30° to 60° , passing through a minimum and then increasing much more rapidly. The values obtained for the same angle differ, however, from night to night according to the state of the atmosphere. Further observation is necessary to obtain results which will give full information as to the nature and distribution of the material which causes the zodiacal light; the measurements made, however, make it clear that the light is diffused sunlight, and that it cannot be due to gaseous molecules, since in that case, while the curve for ρ would be of the form observed, the values of ρ would only be from half to one-third as large. The particles must have dimensions which are not negligible as compared with the wave-lengths concerned.

CARBONISATION OF COAL.—In pursuance of a policy mentioned in NATURE (September 20, 1924, p. 441) the Fuel Research Board has tested the carbonisation plant of Midland Coal Products Ltd., Netherfield, Nottingham, and the results have been published (H.M. Stationery Office, 9d. net). The coal treated is a poorly caking local slack which is first briquetted. Carbonisation is effected by internal heating in a tall brick-lined shaft, water-jacketed at the base, a portion of the fuel being gasified by the air-steam mixture injected. The producer gas so generated reduces the calorific value of the gas to 190 B.T.U. per cubic foot—a figure too low for public supply. The yields of products obtained were: coke 7.5 cwt., gas 58,300 cubic feet or 112.5 therms, tar 21 gallons. The ammonia liquor was too dilute for profitable recovery. The coke was well carbonised with 2 per cent. only of volatile matter, and though suited for use in stoves, it was unsuitable for open grates. Its ash content was 9.13 per cent. The temperature reached in the charge was 1200°C. , and the process cannot be classed as a low temperature carbonisation in the sense commonly understood. The tar yield was high, but the proportion of light oil was small. The pitch obtained was used for the briquetting. It was considered that the grade of coke might be improved by the use of more suitable elevating plant. No attempt is made to assess the commercial success, but the results do not suggest that the process is one which will prove a general solution to the problem of providing smokeless fuel.

Geneva Congress of the History of Medicine.

THE Fifth International Congress of the History of Medicine was held at Geneva on Monday, July 20–Friday, July 24, under the presidency of Dr. Charles Greene Cumston, lecturer in the history of medicine at the University of Geneva, with Sir D'Arcy Power as president of honour. The meetings, which were held at the Athénée, where the conference leading to the formation of the Red Cross took place in 1863, were well attended, representatives being present from Belgium, Cuba, Denmark, France, Great Britain, Holland, Italy, Morocco, Poland, Spain, Switzerland, and the United States.

At the opening meeting the president gave an account of the medical celebrities of Geneva, including Daniel Le Clerc (1652–1728), whose history of medicine was published twenty-nine years before Freind's "History of Physick"; Jean Antoine Sarasin (1547–1598), the author of a treatise on plague, and Théophile Bonet (1620–1689), who wrote a work on morbid anatomy entitled *Sepulchretum*, which secured him a European reputation. Dr. André Patry, president of the Medical Society of Geneva, then gave a sketch of ophthalmology in Switzerland from Roman times. Addresses were next delivered by M. André Oltramare, Chief of the Department of Public Instruction, representing the Council of State; M. Georges Werner, Rector of the University of Geneva; Dr. Hugues Oltramare, representative of the City of Geneva, and Dr. Tricot-Royer, of Antwerp, president of the International Society of the History of Medicine. Prof. Eugène Pittard, of the University of Geneva, then delivered a lecture on the prehistoric period of medicine, illustrated by skulls and implements from French and Swiss burial mounds. He showed that trephining of the skull was fairly frequent among prehistoric peoples, being usually performed in the parietal and rarely in the occipital or frontal regions.

On Tuesday papers were read at the morning session by Dr. J. D. Rolleston, on Voltaire and English doctors; by Sir D'Arcy Power, on Albert von Haller and the *Disputationes Chirurgicae Selectae*, i.e. M.D. theses written in various European universities between 1699 and 1742 and edited by Haller; by Dr. John Comrie, of Edinburgh, on Robert Whytt, an eighteenth-century neurologist, by Dr. A. Guisan, of Lausanne, on the life of Fabricius Hildanus, a Basel practitioner of the sixteenth century, by Dr. J. G. de Lint, on Tronchin and the Suttons' method of inoculation, by Dr. E. Wickersheimer, on syphilis in Geneva at the end of the fifteenth century, who combated the view that the disease had been imported for the first time by Columbus from America; by Prof. Wiki, on Dr. Karl Nicolaus Lang, who described the epidemics of ergotism at Lucerne in 1709 and 1717, by Dr. Maillart, on abdominal ex-votos found in the Museo delle Terme at Rome; and by Mlle. Eugénie Droz, on a plague tractate of the thirteenth century.

The afternoon session was taken up by papers by Dr. Paul Delaunay, on the doctors of Le Mans in Switzerland during the sixteenth century; by Dr. J. W. S. Johnsson, of Copenhagen, on an autograph letter of Fracastor in which poetry is described as a kind of disease, by Prof. F. M. Messerli, on three sanitary edicts at Lausanne in the fifteenth and sixteenth centuries, by Mr. C. J. Thompson, on hygiene and public health in early civilisations; and by Prof. P. Capparoni, on anatomical instruction at Rome during the sixteenth century.

After the close of the session the members of the Congress were entertained by Dr. and Madame Rilhet

at Vengeron, where they were able to inspect the library of the paediatrist, Dr. Frédéric Rilhet.

On Wednesday morning papers were read by Dr. R. O. Moon, on Paracelsus and medicine; by Dr. E. B. Krumbhaar, on the medical literature of the seventeenth century as exemplified in the Elzevir press, by Dr. H. Renaud, on some recent discoveries bearing on the history of Arabian medicine in Morocco; by Prof. Jeanselme, on the Germanic conceptions of surgical anatomy at the time of the barbaric invasions, by Dr. Tricot-Royer, on the history of lepers at Antwerp and Louvain; and by Dr. M. A. van Andel, on medicine and architecture.

In the afternoon session papers were read by Mrs. Lilian Lindsay, on the growth of dentistry in England from the earliest times to the beginning of the nineteenth century; by Prof. Wrzosek, on Remak and Polish science, showing that Remak published several scientific works in Polish before he settled in Berlin, and on Emmanuel Glibert, who organised the medical school at Grodno (1776–1780), at a time when numerous French doctors were practising in Poland; by Dr. E. Wickersheimer, on Jean Gispaden, a fifteenth-century surgeon of Annecy and Grenoble; by Dr. Tricot-Royer, on Isaac Ammon, otherwise known as Palatino Chaldaico, a physician and astrologer; by Dr. de Metz, on the barber-surgeons of Antwerp; by Dr. Dubreuil-Chambardel, on the houses of refuge on the pilgrim routes in the tenth, eleventh, and twelfth centuries; by Dr. Laignel-Lavastine, on his ancestor, the oculist Jacques Daniel, who performed the first operation for cataract on April 8, 1785, at Marseilles, and by the same speaker, in collaboration with Dr. Jean Vinchon, on demoniacal possession in the sixteenth century.

After the meeting a visit was paid to the public library, where a special exhibition of manuscripts, incunabula, and other works bearing on the history of medicine, had been arranged, and portraits of Geneva physicians from the sixteenth to the eighteenth century were on view. In the evening there was a reception by the Administrative Council of the City of Geneva at the Palais Eynard.

Thursday was devoted to a tour on the Lake of Geneva, a visit being first paid to the Château de Chillon, and then to Evian-les-Bains.

On Friday morning, when the Congress was brought to a close, Dr. Wierzbicki read a paper by Prof. A. Wrzosek and himself on auscultation in Poland in the first half of the nineteenth century; Dr. J. W. Courtney, of Boston, dealt with Benjamin Waterhouse, who introduced vaccination into the United States; Dr. De Alcalde, of Madrid, showed an iron crown found in a Spanish cloister which was credited with the power of curing diseases of the head and mental disorders; Dr. Bugiel described the life of the Polish students at the Paris Faculty of Medicine in the thirteenth, fourteenth, and fifteenth centuries; Dr. J. B. Hurry contributed a paper on J-Em-Hetep, Prime Minister to King Zoser and afterwards the medical god of Egypt; Dr. A. De Peyer, the general secretary of the Congress, read a communication from Prof. Pierre Gautier on the history of typhoid fever in the child, and himself contributed a paper on his ancestor, Johann Conrad Peyer, a seventeenth-century physician of Schaffhausen, who has given his name to the patches of lymph follicles in the small intestine.

The next Congress of the History of Medicine will be held in July 1927 at Leyden, under the presidency of Dr. J. G. de Lint.

Economic Problems.

THE proceedings of Section F (Economic Science and Statistics) of the British Association were marked this year by the variety and the number of the topics discussed. They were noticeable also in that a lady economist, Miss Lynda Grier, occupied the presidential chair of the Section. Taking "The Meaning of Wages" as the subject of her address, Miss Grier stated that it was not her intention to put forward a new theory of wages but rather to analyse and restate certain aspects of the wages problem under the three headings: (1) the distributive or competitive aspect, (2) wages as the product of the worker, and (3) the effect of the wages paid on the work and the supply of workers. We are being forced increasingly to discuss, she remarked, those measures which attempt to add to the normal wage rate or to "stretch" the rate so that it will pay for things that it did not previously pay for. Such measures include schemes for fixing minimum wage rates which do not increase productivity, cost of living sliding scales, systems of family allowances, compulsory insurance schemes, and schemes for subsidising certain sections of the wage-earners of the community.

In opening a joint discussion with the Agricultural Section on the "Marketing of Agricultural Products" Mr R. B. Forrester said that in Britain very little serious attention has as yet been directed to the examination and analysis of marketing methods. Recent developments in other countries seem to show that a widespread tendency has set in towards improvement of marketing methods by means of control of quality and the setting up of grades or standards. So far, this has been especially associated with the efforts of the farmers themselves, though government

action has been of great help in providing scientific assistance and impartial inspection. It would seem that the British producer will also be compelled to give attention to marketing developments, which so closely affect competition in the home market. No alterations of a radical character are, however, to be expected in Great Britain unless they have the support of the farmers themselves, since changes in marketing are bound to involve important modifications in the system of production.

A young Swedish economist, Mr Fabian v Koch, gave an interesting account of unemployment relief in Sweden. The abnormal conditions of the post-War period are now practically at an end in that country. No insurance scheme has been initiated, though a provisional and restricted system of unemployment relief has been organised. The available funds have gone for the most part to State relief work, and only a small fraction has been devoted to the granting of doles or unemployment benefit. The principle has been accepted that relief work wages shall in all cases and localities be less than the ordinary wages that are paid.

Dealing with "The Economics of Family Endowment," Mrs Stocks asserted that inadequate attention has been given by theoretical economists to the problem of the family and its place in the economic structure. But, from recent statistical and social investigations, the fact has emerged that current output is insufficient to ensure the payment of a living wage so long as wages are paid at a flat rate without respect to the family responsibilities of the wage-earner. This is the basis of the plea for family endowment and the argument on which its advocates base their case.

The North Atlantic in Tertiary Times.

THE resemblances between the Tertiary faunas of the West Indies and those of the Mediterranean region have long been noticed and have been taken to indicate the former existence of shallow water across the Atlantic from the West Indies to Northern Africa, along which the migration of animals could take place. This subject, so far as the Miocene and Pliocene periods are concerned, has been more fully investigated by W. P. Woodring (Bull. Geol. Soc. America, 35, 1924, pp. 425, 867), who finds that the resemblance of the Miocene mollusks of the West Indies to those of the Mediterranean area is even closer than was formerly supposed—the resemblance being particularly striking to the fauna of the Piedmont basin of Italy. The similarity reached its maximum in the Helvetian period, when the Miocene transgression of the sea was at its greatest in both regions.

The Miocene faunas of the east coastal part of North America give clear evidence of the existence of climatic regions, in fact the distinction between tropical, sub-tropical, and temperate faunas is almost as striking as at the present day. It is therefore only natural that some differences should be found between the Miocene faunas of the Mediterranean and those of the West Indies; the former include temperate elements which are unknown in the latter and give them a sub-tropical aspect. The Mediterranean faunas are also characterised by the large number of exotic genera. The fact that so many genera, belonging to many different families, are common to both regions can scarcely be explained except by migration.

It is evident that this migration of tropical or sub-tropical genera could not have taken place along the northern border of the Atlantic, and Woodring concludes that there must have been series of shoal-water banks or islands extending across the southern part of the North Atlantic in Miocene times, but that these disappeared in late Miocene or Pliocene times, when the resemblances between the faunas of the two regions diminish. The present configuration of this part of the Atlantic floor, however, shows no sign of the former existence of shallow water or islands. In the Mediterranean region the sub-tropical faunas of the Miocene and Pliocene periods were replaced in Quaternary time by a temperate fauna coming from the North Atlantic.

In a later memoir, Woodring (Carnegie Institution, Publ. 366, 1925) describes the Miocene lamellibranchs and scaphopods from Bowden, Jamaica, and expects in a subsequent part to discuss the character and significance of the fauna. Dr T. Wayland Vaughan has on more than one occasion pointed out resemblances between the coral faunas of the western side of the Atlantic and those of the Mediterranean region in Eocene, Oligocene, and Miocene times. In a short paper (Bull. Geol. Soc. America, 35, 1924, p. 823) he recurs to this subject and states that in the West Indies the resemblance is greatest (1) between the Upper Eocene of St. Bartholomew and the Priabonian of Northern Italy, and (2) between the Oligocene of Antigua and the Rupelian of Northern Italy.

Engineering and Shipbuilding.

THE causes of the present depression in engineering and shipbuilding and ways and means of mitigating the results formed the subject of the address delivered by Sir Eustace H. Tennyson d'Eyncourt on October 16, as president of the North-east Coast Institution of Engineers and Shipbuilders. Employers and employees, manufacturers and owners must pull together and not attempt to row the boat in opposite directions, this is especially necessary now, since there has never before been a time when such strenuous efforts were being made to stir up strife. One of the chief causes of the present trouble is the over-production which took place in the later years of the War and immediately following. There is little doubt that many of the vessels laid up at present are old, or becoming obsolete, and probably will never be put in service again.

Improvements in machinery and other features of ships are so rapid that older vessels soon have to give way to more up-to-date craft which can be run more economically. Higher steam pressures will come, and we shall soon see boilers and turbines with at least double the usual present-day pressure—one vessel is now being built on the Clyde, for passenger traffic there, with high-pressure boilers and turbines. Our knowledge of the best dimensions for propellers has been considerably added to, as has also the improvement in the form of the hull, on both of which important work has been done at the Froude Tank at the National Physical Laboratory, and at other tanks.

In the construction of the hull there is room for considerable improvement in steel. The ordinary mild steel has remained practically unchanged in quality during this century. Special attention has been given to high-tensile steel in the Navy, and Sir Eustace thinks that steel of improved quality could be made and adopted at any rate for the more important portions of the structure of merchant ships.

Labour questions, including that of the loss of many of our highly skilled men who have gone to other countries, were also touched upon. The present conditions are jeopardising the supremacy of our industries, and Sir Eustace thinks that the whole position is more clearly understood by other nations, both on the Continent and in the United States. He has made a close study of relative costs, and thinks that the low prices which can be accepted abroad are due to a combination of factors—longer hours and slightly lower wages, lower rates and taxes; more elasticity allowed to workmen doing various kinds of work, full advantage taken of labour-saving appliances; many of the materials used are somewhat less costly, less elaborate and expensive ship's fittings are accepted by owners. In fact, a somewhat lower standard of living is accepted by the workers, and a lower standard of article by the purchasers.

University and Educational Intelligence.

BIRMINGHAM.—Prof. F. W. Burstell, for some time Dean of the Faculty of Science, has been appointed Vice-Principal, in succession to Sir William Ashley, who resigned at the end of last session.

The Walter Myers Travelling Studentship (value 300*l.* for one year) has been awarded to Miss Edythe Milne Bankier.

The date of the celebration of the Centenary of the Medical School is fixed for December 8 next, but arrangements for the celebration are not yet complete.

CAMBRIDGE.—On November 3 the Senate discussed some of the statutes proposed by the Royal Commission, and many points were raised. Among them was the suggestion that the Forestry Department should be made a part of the Faculty of Agriculture. Some speakers felt that it was unfair to place a limit on the period of tenure of demonstratorships.

The Council of the Senate has presented a report in which it is pointed out that whereas the possession of a Cambridge degree is supposed to signify that the bearer has participated in the life of the University, it is now possible in certain circumstances for research students to obtain degrees after only three terms of residence. It is proposed that the new statutes shall require at least five terms of residence, a scheme which would undoubtedly enhance the value of research degrees. Concessions would be made to graduates of Oxford and Dublin.

It is proposed that a committee of management shall be set up to deal with the Polar Research Institute, for which 13,000*l.* was provided from the Captain Scott Memorial Fund.

Dr. Dean, professor of pathology, and Mr. T. Knox Shaw, tutor and mathematical lecturer of Sidney Sussex College, have been elected members of the Council of the Senate.

Among the fellows recently elected at St John's College were Dr F. H. Constable (biochemistry) and Messrs E. G. Dymond and T. G. Room (mathematics).

Mr H. Godwin has been elected to a fellowship at Clare College. Mr Godwin was formerly a scholar of the College and is now junior (University) demonstrator in botany, he is carrying on research work on the respiration of leaves.

Queens' College now elects its entrance scholars on the results of the Higher School Certificate Examinations; of the five elections recently announced, one is for science and one for science with mathematics. At Pembroke College, of eight 80*l.* exhibitions announced last week, two were for mathematics and two for science.

Applications are invited for the Pimsent-Darwin Studentship in Mental Pathology. The studentship is of the annual value of about 200*l.* and is tenable for three years. Further particulars may be obtained from the Registry of the University of Cambridge, and applications for appointment should be sent before December 1 to the Secretary, Pimsent-Darwin Studentship, Psychological Laboratory, Cambridge.

LONDON.—Applications are invited for the Rogers prize for 1926 for the best essay on "The Value of the Various Methods of investigating Diseases of the Pancreas." The value of the prize is 100*l.*, and the competition is open to all whose names appear on the Medical Register of the United Kingdom. Information can be obtained from the Academic Registrar, University of London, South Kensington, S.W.7.

ST. ANDREWS.—Dr. F. Nansen has been elected Rector of the University to succeed Dr. Rudyard Kipling. The following appointments have been made by the University Court: Mr. H. J. R. Kirkpatrick to be lecturer in regional anatomy and assistant to the Bute professor of anatomy in the United College, Mr. D. L. Pritchard to be assistant in mathematics, and Dr. Margaret Scott Dickson, assistant in public health.

The degree of D Sc has been conferred on Mr. R. S. Vaidyanathaswamy, of Madras, for a mathematical thesis entitled "Studies in Form-Theory."

THE British Research Association for the Woollen and Worsted Industries announces the following

awards for the year 1925-26.—Research fellowships to Mr. J. R. Nichols, to enable him to continue his researches at the animal Breeding Research Department of the University of Edinburgh, on the fibres of various breeds of sheep; and to Miss J. S. S. Blyth, to conduct research at the Animal Breeding Research Department, Edinburgh, on the microscopical examination of the fleeces of British breeds of sheep; advanced scholarships to Mr. H. S. Bell, at the University College, Nottingham, and to Mr. W. Riddle, at the Scottish Woollen Technical College, Galashiels.

For the sixth year in succession, Trinity College, Cambridge, announces the offer of a Research Studentship open to graduates of other universities who propose to come to Cambridge in October next as candidates for the degree of Ph.D. The value of the studentship may be so much as 200*l.* a year. Applications must reach the Senior Tutor by July 25, 1926. The College is also offering, as usual, Dominion and Colonial Exhibitions of 40*l.* or (in cases of special need) about 72*l.* to students of Dominion and Colonial universities who wish to come to Cambridge next October as candidates for the degree of B.A., M.Litt., M.Sc., or Ph.D. Candidates must apply through the principal authority of their university, and applications should reach the Senior Tutor (from whom further particulars may be obtained) by July 1, 1926.

TRAVELLING studentships for university graduates are provided on a remarkably liberal scale by the National University of Ireland. In the new Calendar, particulars are given of five such studentships of the value of 200*l.* each, open to graduates of the University, offered in the following subjects for competition in 1926: economics, experimental physics, agriculture, physiology, and modern languages (two of—English, French, and German). Reference is still made in the Calendar to the Royal College of Science, Dublin, as an institution at which may be taken the practical course required to be pursued in the second year of the course for the bachelorship in engineering. We understand, however, that the buildings and equipment are being transferred to University College, Dublin.

THE Charles' University (Universita Karlova) of Prague has published in English a prospectus, specially prepared for foreign students, of its Faculty of Science. It offers a doctorate in science (Rerum Naturalium Doctor) on conditions which do not necessarily involve a knowledge of the Czech language or a prolonged stay in the country. Any part of the required four or five years of university work may be taken at any university of recognised standing, the thesis may be in English, French, German, or Russian, and the two (oral) examinations may be conducted in any of these languages. The thesis must embody the results of original research constituting a distinct advancement of science. Among the departments in which facilities for specialist study and research are offered are those of meteorology, pharmaceutical botany, anthropology and demography, photography and photochemistry, methodology and history of the natural sciences and of the exact sciences. The University maintains a Department of Athletics and Physical Training which offers, free of charge to students, facilities for football, swimming, rowing, tennis, ski-ing, skating, etc., and the Faculty of Science arranges ski-ing parties for which special reduced student rates for railway journeys and hotel accommodation are obtainable. Special arrangements are made by the student body for welcoming foreign students and helping them to find suitable accommodation.

Early Science at Oxford.

November 15, 1687. A letter was read from Dr. Garden concerning the formation of animals. In which he reconciles the opinions concerning the formation ex Animalculis and ex Ovo, in these positions: first animals are formed ex Animalculis, 2d that these Animalculæ are in semine Marium et non in fœminis; 3dly that the ovum fœminarum is this nidus requisite to the production of the animals.

There was also read a relation of a dismall tempest at Hullavington, communicated by Mr. Cole of Bristol.

November 16, 1683. Dr. Plot shewed us ye two peices of a magnet, which he had lately cut *secundum Equatorem*; they were now two Magnets, and referred to one another, as when they were one whole; contrary to what was found in ye division *secundum Meridianum*.—And, with Dr. Tyson, he gave an account of Hair-balls. 'Twas observed that ye grain of ye hair, was all one way, which was caused (possibly) by ye motion of ye ball in ye stomach.

Mr. Piggot read an account of Chylification, which was put into his hands by a freind of his, who desires to be anonymous to us: the Author says, he has a liquor, some few drops of which will turn spittle, ye broths of beef, mutton, and veal, as also ye flesh it self, to a white color; arguing from thence, that probably ye great menstruum of ye stomach, may be of ye same nature, with his liquor, Mr. Piggot says he saw these experiments tried with success.

November 16, 1686. An account of one Mrs. Brown in Oxford who dyed of a *dropsie*, out of whose body was taken by measure 16 gallons of water wanting a quart, all contained in one great bag which was continued with the ovarium.

An account was received from Mr. Halley of a *little man*, lately presented to the French king, being 37 years old, and with a great beard, and yet but 16 inches high. Likewise of a transparent substance lately invented in France, made out of Hogs bladders, fit to be used instead of coach glasses because it will not break.

An account of an experiment made at the spire of the Cathedral in new Sarum, Nov 1684, with the *Baroscope* by Colonel Windham and Mr. Warner.

November 17, 1685. Mr. Bobart presented a catalogue of ye leaves and seeds of plants lately brought from St. Christopher's and shewn us ye last meeting.

Mr. Pigot junior informed ye Society, that not long since he opened a dog by entering ye abdomen a little above ye Os Pubis according to Dr. Lister's direction, ye dog was kept above a fortnight after this, (in which time he recovered gradually) and then ran away. Mr. Pigot farther informs ye Society that in a late dissection of a dog he observ'd Lacteals to rise from ye bottom of the stomach, contrary to the opinion of some late anatomists.

Dr. Plot comunicated ye *Byssus marinus* of a *Pinna marina* mentioned by Rondelet.

November 18, 1684. A letter from Mr. Aston was read, giving an account of severall experiments mentioned in a book lately written by Kunckell, being sent over by ye Elector of Brandenburg, these experiments were ordered to be tried. Mr. Desmastes took ye trouble upon him.

A letter from Mr. Packer, Physitian at Reading, mentions a hollow oak, not far from Early Court in Berk-shire, which, as he is inform'd, is 18 yards in compass at ye bottom, but lessens apace from ye ground. He promises a full account of this thing as soon as his occasions will suffer him.

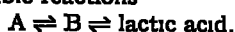
Societies and Academies.

LONDON.

Royal Society, November 5.—L. Ballif, J. F. Fulton, and E. G. T. Liddell: Observations on spinal and decerebrate knee-jerks, with special reference to their inhibition by single break-shocks. Simultaneous mechanical torsion-wire myograph and electrical records have been obtained of knee-jerks in decerebrate and spinal preparations. The spinal knee-jerk differs from the decerebrate: the mechanical response of the spinal jerk is two to three times longer in duration than that of the decerebrate jerk (or the motor twitch); the curve of relaxation of the spinal jerk is different; the electrical response tends to be more prolonged in the spinal knee-jerk; the interval between the tap and the electrical response is greater in the spinal preparations; and the spinal jerk is more difficult to elicit. The shortest spinal knee-jerk observed seems to be produced by a repetitive discharge of at least 4 to 8 volleys of impulses recurring somewhat asynchronously at 100 to 200 per sec. Both spinal and decerebrate knee-jerks may be inhibited by a single appropriately timed break-shock applied to an ipsilateral afferent nerve, the former much more readily than the latter. When recovering from an inhibition, the spinal knee-jerk has the same duration as a twitch or a decerebrate knee-jerk.—K. Furusawa: (1) Muscular exercise, lactic acid, and the supply and utilisation of oxygen. Pt. xiii. The gaseous exchanges of restricted muscular exercise in man. A simple ergometer, capable of being worked at any speed by the arms, has been constructed. As regards oxygen requirement, there is a marked optimal speed but no optimal load. Oxygen intake rises much more slowly to its maximum value than it does in the case of exercise involving most of the muscles of the body. It seems that lactic acid produced in excess by violent activity of a localised group of muscles may diffuse from them into the blood, and thence to other parts of the body (particularly resting muscles and liver), and there be removed or restored to glycogen under the influence of oxidation occurring in those tissues. There appears, therefore, to be possibility of an exhaustion due to complete using up of lactic-acid precursor, when the exercise involved is localised in a small group of muscles. (2) A spirometer method of studying continuously the gaseous metabolism of man during and after exercise. A new method is described of studying continuously the rapidly altering gaseous metabolism of man during and after muscular exercise. A spirometer of large capacity is used, the gases inside it being kept continuously stirred, the total ventilation being measured every 10 litres, and samples being abstracted at intervals for analysis.—D. T. Harris: The effect of light on the circulation. Irradiation of a localised area of skin with ultra-violet energy causes a widespread peripheral vaso-dilation. Consequently, only a very slight transitory rise of blood-pressure results from the small increase in pulse rate of from two to five per minute in dark and white subjects respectively. The reaction was always less in pigmented subjects. The vaso-dilator response to ultra-violet radiation is enhanced by a previous exposure; this is not the case with radiant heat. The vascular response appears to be a nervous reflex initiated by a nocuous stimulus; the whole phenomenon is one of incipient injury.—A. V. Hill: The surface tension theory of muscular contraction. The amount of lactic acid liberated when a muscle fibre 1 cm. long develops a force of 1 dyne is 1.46×10^{-11} gm. This is very

nearly 10^{11} molecules. Spread out in a continuous mono-molecular film these would occupy about 2.1×10^{-4} sq. cm. If the mechanical response of muscle were due to a change of surface tension caused by such a film, the coefficient of surface tension required would be about 4800 dynes per centimetre. This is about 230 times the tension of a water—olive-oil interface, clearly an impossible value. Reckoned per gm. of muscle, the amount of lactic acid liberated in a maximal contraction of a frog's muscle is about 0.033 mgm., which would occupy an area of about 470 sq. cm.; i.e. about the surface area of the fibres composing the muscle.—J. F. Fulton and E. G. T. Liddell: Electrical responses of extensor muscles during postural (myotatic) contraction. Simultaneous mechanical and electrical records have been obtained of the responses of quadriceps femoris and rectus femoris of decerebrate cats to various forms of postural (myotatic) reflex. The knee-jerk seems to be produced by a somewhat asynchronous volley of impulses. The comparative absence of electrical responses in stretch reflex is due to complete asynchronism of afferent stimuli, for when a large number are recruited synchronously an action current invariably occurs. Since the exaggerated stretch reflex characteristic of the decerebrate condition is in large measure responsible for rigidity of extensor muscles in the decerebrate animal, we have inferred that these sustained postural reactions are produced by asynchronous all-or-nothing contractions of individual muscle fibres rather than by hypothetical fixing mechanisms.—L. N. Katz: On the supposed pluri-segmental innervation of muscle fibres. In the frog, when the two components of the sciatic nerve are stimulated in succession in an isometric tetanus, the sum of the tension developed is considerably greater than the tension produced when both components are stimulated simultaneously. The total heat developed on stimulating the two components of the sciatic nerve separately is, however, the same as that produced when they are stimulated simultaneously. This indicates that there is no pluri-segmental innervation of frog's muscle fibres apart from possible infrequent chance variations.—L. N. Katz and C. N. H. Long: Lactic acid in mammalian cardiac muscle. Pt. i. The stimulation maximum. The mammalian heart is dependent on its contemporary oxygen supply, and fails rapidly in its absence; the skeletal muscle, on the other hand, is independent at first of its contemporary oxygen supply. The data obtained from cats and rabbits show that the mean lactic-acid stimulation maximum of the heart is approximately one-third that of the skeletal muscle. The maximum "oxygen-debts" of these two tissues should therefore be in the same ratio.—H. J. G. Hines, L. N. Katz, and C. N. H. Long. Lactic acid in mammalian cardiac muscle. Pt. ii. The rigor mortis maximum and the normal glycogen content. The rigor mortis maximum, or the caffeine rigor maximum, of lactic acid in the heart is only half that in the skeletal muscle. A lack of lactic-acid precursor is not the cause of the relatively low stimulation maximum in the heart. The glycogen content of the heart is much smaller than that of skeletal muscle in well-fed cats. There is in the heart a greater discrepancy between resting glycogen content and the lactic acid produced in rigor mortis, than there is in skeletal muscle. It indicates that a greater portion of the lactic-acid precursor of the heart is in some other form than glycogen.—Phyllis Kerridge, L. N. Katz, and C. N. H. Long: Lactic acid in mammalian cardiac muscle. Pt. iii. Changes in hydrogen-ion concentration. The hydrogen-ion concentration of cardiac and of

skeletal muscles stimulated to fatigue are different; the difference is of the order of 0.2 pH, the skeletal muscle being the more acid. In rigor mortis the difference is of the order of 0.4 pH, the skeletal muscle being the more acid. Cardiac and skeletal muscle have different buffering powers which vary at different pH's. The maximum difference is at approximately 6.3 pH, when the ratio of the buffering power of skeletal to that of cardiac muscle is about 2:1.—W. E. Garner: The mechanism of muscular contraction. It is suggested that the tension generated on applying a stimulus to a muscle fibre is due to the formation of a solid film on the surfaces of the ultimate fibrils of the muscle. Liquid crystals composed of long-chain carbon compounds are present in the anisotropic segments of the muscle, and the molecules of the long-chain carbon compounds are orientated with their chains in a direction parallel to the axis of the fibre. It is suggested that glycogen is converted into sodium lactate according to the series of reversible reactions



where A is a product formed from glycogen and B is an intermediate active form of both A and lactic acid. The direction of the chemical reaction may be influenced by alteration of the surface energy of the membranes during movements of the muscle. When the energy liberated during the conversion of glycogen into lactic acid is not utilised in doing external work, it may be stored, in part, by a reversal of the reactions.—R. W. Riding and E. C. C. Baly: The occurrence of helium and neon in vacuum tubes [Proc. A 749 (September), pp. 186-193].—O. W. Richardson: Structure in the secondary hydrogen spectrum (iii). [Proc. A 750 (October), pp. 239-266].—T. R. Merton and J. G. Pilley: On the excitation of the band spectrum of helium. [Proc. A 750 (October), pp. 267-272].—H. Hartley and J. E. Fraser: The conductivity of uni-univalent salts in methyl alcohol at 25° C. [Proc. A 750 (October), pp. 351-368].—C. S. Beals: The arc spectrum of palladium. Its Zeeman effect and spectral type. [Proc. A 750 (October), pp. 369-384].—N. Ahmad: Further experiments on the absorption and scattering of γ-rays. [Proc. A 749 (September), pp. 206-223].—R. A. R. Tricker: A determination of the variation of the mass of the electron with velocity, using homogeneous β-rays. [Proc. A 750 (October), pp. 384-396].—E. H. Boomer: Experiments on the chemical activity of helium. [Proc. A 749 (September), pp. 198-205].—R. M. Wilmette: On the construction of a standard high-frequency inductive resistance and its measurement by a thermal method. [Proc. A 751 (November), pp. 508-522].—R. B. Brode: The absorption coefficient for slow electrons in the vapours of mercury, cadmium, and zinc. [Proc. A 750 (October), pp. 397-405].—P. Kapitza and H. W. B. Skinner: The Zeeman effect in strong magnetic fields. [Proc. A 749 (September), pp. 224-239].—F. R. Weston: The flame spectra of carbon monoxide and water gas. Pt. II. [Proc. A 751 (November), pp. 523-526].—H. S. Hirst and E. K. Rideal: The thermal decomposition of nitrogen pentoxide at low pressures. [Proc. A 751 (November), pp. 526-540].—R. W. Gurney: The number of particles in the beta-ray spectra of radium B and radium C. [Proc. A 751 (November), pp. 540-561].

MANCHESTER

Literary and Philosophical Society, October 27.—S. J. Hickson: The life and work of Georg E. Rumphius (1627-1702). Among the early pioneers of the sciences of botany and zoology, Georg Everard Rumphius (or Rumphius) occupies a prominent if not

an outstanding position. His work was done in the remote island of Amboyna in the Malay Archipelago, but owing to a series of calamities only his two books, "Het Amboinsche Kruidboek" and "D'Amboinsche Rariteitkamer," were preserved in a form sufficiently complete for publication. His three books on the land, air and water animals of Amboyna were lost, as were also the greater part of his books on the history of the island and the description of the country. Rumphius was born and educated in Hanau, a German city, but there is reason to believe that his family was of Dutch descent. The date of his birth must have been either 1627 or 1628. He arrived eventually in Amboyna in 1653, at the age of about twenty-six years. He exchanged from the Dutch army into the Civil Service and settled down as a Resident in the northern province of Hitoe of the island of Amboyna, and it was in the capital town, Hila, on the sea coast of this beautiful island, that the greater part of his work was done. For some years his life appears to have been happy and uneventful, but in 1670, when he was forty-three years of age, he became totally blind by cataract in both his eyes. He was removed to Amboyna, but with the help of his son Paul continued his work until his death in 1702. In 1674 his wife and youngest daughter were killed in the terrible earthquake that ravaged the island in that year. In 1687 many of his books, manuscripts and drawings were destroyed in a disastrous fire that burned down his house, and to complete the misfortunes of this most unfortunate man, the whole of the original manuscripts and drawings of the first six books of his Amboyna Herbarium were lost when the ship *IVaterland*, in which they were being conveyed to Holland, was captured by the French and destroyed. Fortunately, by the order of the Governor-General a complete copy of this work was made before it left Java, and this copy reached Holland in safety.

PARIS.

Academy of Sciences, September 28.—F. E. Fournier: The prevention of collisions at sea. The international rules at present in force are insufficient to prevent collisions between vessels during fog. A scheme of wireless signals giving greater security is suggested.—H. Deslandres: Complementary researches on the structure and distribution of band spectra. On the basis of the data of Coblenz on infra-red spectra, the author finds confirmation of his general formula given in earlier communications.—E. Bataillon: The first parthenogenetic kinesis in *Bufo vulgaris* and the mechanism of the regulation.—A. S. Besicovitch: Some points in the theory of nearly periodic functions.—F. Carlson: Some mean values of an analytical function.—Jean Dufay: The polarisation of the zodiacal light. Visual observations have given contradictory results regarding the polarisation of the zodiacal light. The author has made use of a photographic method, details of which are given, and finds that his results confirm the view generally held, that the zodiacal light is only diffused solar light.—Arabu: The tectonic of the field of faults of Ribeaupillé (Haut-Rhin) to the north of Strengbach.

WASHINGTON, D. C.

National Academy of Sciences (Proc. Vol. 11, No. 9, September).—C. Dale Beers: Encystment and the life cycle in the ciliate *Didinium nasutum*. Under favourable and adequate conditions, there is no definite life cycle, and encystment does not occur periodically. Scarcity of food causes the formation

of cysts which are all considered to be protective in nature. Excretion products of *Paramoecium* inhibit encystment. excretion products of *Didinium* promote it—Sophia Satina and A. F. Blakeslee. Studies on biochemical differences between (+) and (-) sexes in *Mucors* tellurium salts as indicators of the reduction reaction. Of the 264 heterothallic races of *Mucor* examined, the (+) races show a higher average power of reducing certain tellurites and selenites than the (-) races. This reducing power seems to be influenced by the sex differential, but other non-sexual factors exert an influence which varies from race to race—Howard B. Frost. Tetraploidy in Citrus. "Thick-leaved" citrus appears to be tetraploid (18 chromosomes, but the number is very variable), the doubling of the chromosome number taking place in the nucellus or in the very young embryo—C. E. Seashore and Milton Metfessel. Deviation from the regular as an art principle. Emotion in music is expressed by slight deviation from the exact and can be analysed by photographing the sound waves. These records show the character of the vibrato used to express emotion in singing, and indicate how various singers obtain their effects by gliding to a note, attacking it, correcting for illusions of hearing by singing what is actually a wrong note, and making slight deviations from exact time.—C. E. Seashore. The rôle of mental measurement in the discovery and motivation of the gifted student. A new type of senior high school examination testing training and aptitude gives a forecast of probable success in college. This is followed by a freshman examination in each subject, which makes possible the immediate organisation of sections on the basis of fitness. These records give a trustworthy measure of each student's capacity—G. A. Miller. Arithmetisation in the history of mathematics—Francis G. Benedict. Skin temperature and heat loss. Skin temperature surveys are made rapidly under various conditions by thermojunction, heat loss is measured by pyranometer (for radiation) and calorimeter chamber (total). Generally there is distinct correlation for all parts of the body, for skin temperature and temperature of the environment. As regards radiation of heat, the human skin seems to act as a true "black-body". Except under exceptional conditions, heat production and heat loss are essentially independent processes—A. J. Dempster. The passage of slow canal rays through hydrogen. Protons of velocity 4.16×10^7 cm per sec (900 volts) pass through many molecules without causing ionisation or exciting light—George Porter. Paine Energy transformations in an unobstructed air current, in an air current containing a dry obstacle, and in an air current containing an evaporating surface; with applications to an aerodynamic psychrometer and to the measurement of atmospheric humidity.—Samuel K. Allison and Alice H. Armstrong. Note on the experimental determination of the relative intensities of some of the molybdenum and copper *K* series lines and the tungsten *L* series lines—P. A. Ross. (1) X-rays scattered by molybdenum. The radiation scattered from the molybdenum shield of the cathode of a standard tungsten tube and of a water-cooled molybdenum tube was examined by an ionisation spectrometer. In each case the measured change of wave-length agreed well with that calculated from Compton's theory of scattering. (2) Ratio of intensities of unmodified and modified lines in scattered X-rays. A photometric study was made of numerous spectrograms and some of Compton's results were incorporated. There is roughly a linear relation between atomic number and the ratio of the intensities—Ernest Merritt. The effect of light on the behaviour of selenium contact rectifiers. The high resistance of

the selenium contact and the tendency of the surface to deteriorate make it unlikely that it will prove of value in radio work. Illuminating the contact has different effects on the rectified current according to the contact pressure and other circumstances—Carl Barus. The acoustic pressure in tubes capped by high resistance telephones, vibrating in different phases.

Official Publications Received.

- Department of Commerce U.S. Coast and Geodetic Survey. Serial No. 509. Geographic Dictionary of the Virgin Islands of the United States. By James William McGuire. (Special Publication No. 103.) Pp. iii+211. 25 cents. Serial No. 811. Tides and Currents in San Francisco Bay. By L. P. Dinwiddie and W. H. Oversher. (Special Publication No. 115.) Pp. iv+125. 50 cents. (Washington Government Publishing Office.)
- The Indian Forest Records. Silviculture Series, Vol. 12, Part 1. Volume and Outturn Tables for Sal (*Shorea robusta*). By S. H. Rowland. Pp. iv+87+7 plates. (Calcutta: Government of India Central Publication Branch.) 12 rupees; 2s.
- Prudenziya Manuals, 3. Bibliography of Books and Papers relating to Agriculture and Botany to the end of the Year 1913. By T. Petch. Pp. ii+236. (Peradeniya: Department of Agriculture.) 2.25 rupees; 4s.
- University College of Swansea. Prospectus of the Department of Engineering for the Session 1925-26. Pp. 68+2 plates. (Swansea.)
- Proceedings of the United States National Museum, Vol. 66, Part 33. Note on the Fishes of Hawaii, with Descriptions of Six new Species. By Eric Knight Jordan. Pp. 43+2 plates. (Washington Government Printing Office.)
- Report of the Aeronautical Research Institute of Tokyo Imperial University, Vol. 1, No. 11. On the Valve Method of Measuring small Motion, with Special Reference to the Precise Recording of Sounds, Pressure Variations and Vibrations. By Jûichirô Okata and Yûhei Yoshida. Pp. 307-319+4 plates. (Tokyo: Maruzen Kabushiki Kaisha.) 50 sen.
- Canada. Department of Mines. Geological Survey. Memoir 147, No. 125. Geological Series. The Palaeozoic Outcrop of Lake Timiskaming, Ontario and Quebec. By G. S. Hume. Pp. ii+123+16 plates. (Ottawa: F. A. Acland.) 35 cents.
- Canada. Department of Mines. Geological Survey. Summary Report, 1924, Part A. Pp. 159. (Ottawa: F. A. Acland.)
- Ministry of Finance, Egypt. Survey of Egypt. Survey of Egypt Paper No. 30. Determination of the Exact Size and Orientation of the Great Pyramid of Giza. By J. H. Cole. Pp. iv+1 plate. (Cairo: Government Publications Office.) 10 P.T.
- Battersea Polytechnic. Report of the Principal for the Session, 1924-25. Pp. 35. (London.)
- Journal of the Marine Biological Association of the United Kingdom. New Series Vol. 15, No. 4, October. Pp. 755-1021. (Plymouth.) 8s net.
- Experiment Station of the Hawaiian Sugar Planters' Association. Red-Strip Disease Studies. By the Staff of the Department of Pathology. Pp. v+80. (Honolulu: Hawaiian.)

Diary of Societies.

FRIDAY, NOVEMBER 13

ROYAL ASTRONOMICAL SOCIETY, at 5.—B. P. Gerasimovic. On the Masses of Stars of Spectral Types F to K.—W. M. H. Graves. The Solar Motion from Stars of Spectral Types F to M.—W. J. Luyten. A List of Dwarf M Stars.—Prof. E. A. Milne. The Equilibrium of the Calcium Chromosphere (second paper).—W. M. H. Graves, and C. R. Davidson. Preliminary Note on the Determination of Effective Stellar Temperatures by the "Prism-spectrograph" Method.—K. Lundmark and W. J. Luyten. The Relation between Mass and Luminosity.—K. Lundmark. Double Spiral Nebulae.—Prof. A. S. Eddington. Electrostatic Forces in a star and the Deviation from the Law of a Perfect Gas.—W. M. Smart. A Comparison of Schlegel's Proper Motions of the Har and AG Zones with Proper Motions Photographically Determined at Cambridge.—L. H. Jeffreys. On the Surface Waves of Earthquakes.

SATURDAY, NOVEMBER 14

ASSOCIATION OF MINING ELECTRICAL ENGINEERS (North of England Branch) (at Newcastle-upon-Tyne), at 3.—J. A. B. Horsley. The Selection Layout, and Maintenance of Electrical Equipments at Collieries.

INSTITUTE OF TRANSPORT (North-East Centre) (at Newcastle-upon-Tyne), at 8.—O. J. Allen. British Main Line Passenger Train Services.

INSTITUTE OF CHEMISTRY AND SOCIETY OF CHEMICAL INDUSTRY (Bristol and S.W. Section) (at University College, Exeter), at 7.30.—Dr. S. Glasstone. The Measurement of Over-Voltage.

PHYSIOLOGICAL SOCIETY (at Cardiff).

MONDAY, NOVEMBER 16

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—F. Rodd. The Origin of the Tunnies.

ROYAL SOCIETY OF MEDICINE, at 5.30.—Sir Arthur Keith. Man's Structural Defects (Lloyd-Roberts Lecture).

ROYAL AERONAUTICAL SOCIETY, at 6.—Informal Discussion on The Autogyro.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—T. Carter. The Engineer his Dis and his Duty in Life (Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30—Capt R. K. Hubbard The Requirements of the Military Motor Vehicle.
ARISTOTELIAN SOCIETY (at University of London Club), at 8—Dr L. A. Reid The Nature of Beauty.
FARADAY SOCIETY (at Chemical Society), at 8—E. D. Campbell A Chemical Theory of Permanent Magnetism—Prof. J. R. Partington and N. L. Anthonioff An Improved Form of Electric Vacuum Furnace—J. R. H. Coultas and E. M. Grouther: A Source of Error in the Mechanical Analysis of Sediments by Continuous Weighing—D. Weimer A Simple Method of obtaining the Size Distribution of Particles in Soils and Precipitates—J. A. V. Butler. Co-ordination and Co-valency—F. G. Tryhorn and W. F. Wyatt Adsorption by Charcoal from Alcohol-Benzene and Acetone-Benzene Mixtures—F. L. Usher. The Nature of the Interfacial Layer between an Aqueous and a non Aqueous Phase.

TUESDAY, NOVEMBER 17

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15—G. Udny Yule Why do we sometimes get Non-sense-Correlations before Time Series? A Study in Sampling and the Nature of Time Series (Presidential Address).
ZOOLOGICAL SOCIETY OF LONDON, at 5.30—Secretary. Report on the Additional made to the Society's Menagerie during the month of October 1925—Dr G. D. Hale Carpenter. Speke's Tragelaph on the lower Isles of Lake Victoria—Dr P. R. Lowe On the Classification of the Tubenares or Petrels—S. Hirst On some New Genera and Species of Arachnida—H. C. Wilkie. The Auditory Apparatus of the Common Mole (*Talpia europaea*)—J. R. Kinghorn A New Genus of Sea Snake and other Reptiles collected by H. M. A. S. *Chelonia* during a Cruise to North Australia.
INSTITUTION OF CIVIL ENGINEERS, at 6—Prof. W. E. Dalby. The Mechanical Properties of Steel.
INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at the College, Loughborough), at 6.45—J. A. Aiton Steam Pipes for Extra High Pressure and Temperature.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at 17 Albert Square, Manchester), at 7—P. Dunsheath. Dielectric Problems in High-Voltage Cables.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7—J. C. Dollman Specialisation and Versatility.
INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduate Section) (at Broadgate Cafe, Coventry), at 7.15—G. A. Goshing, C. Ballard, and others Discussion on Traffic Control and Organisation.
INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Wolverhampton), at 7.30—Capt. R. K. Hubbard The Requirements of the Military Motor Vehicle.
INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (Glasgow), at 7.30.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middleborough Branch) (at Cleveland Scientific and Technical Institution, Middleborough), at 7.30—W. T. Butterwick Tonnage.
ROYAL ANTHROPOLOGICAL SOCIETY (Indian section), at 8.15—Dr E. H. Hunt Recent Work on Hyderabad Carni Rituals.

WEDNESDAY, NOVEMBER 18

ROYAL METEOROLOGICAL SOCIETY, at 5—Sir Gilbert Walker and E. W. Bliss On Correlation Coefficients their Calculation and Use—Miss Catherine G. Statens. Note on the Variations in Transparency of the Atmosphere observed by Means of a Projected Telescopic Image of the Sun—N. L. Silvester. Notes on the Behaviour of certain Plants in relation to the Weather.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5—Prof. W. Wright The Medieval Conception of the Anatomy and Physiology of the Central Nervous System (Thomas Vicary Lecture).
GEOLOGICAL SOCIETY OF LONDON, at 8.30—W. L. F. Nuttall A Revision of the Orbitoides of Christmas Island (Indian Ocean)—W. Campbell Smith The Volcanic Rocks of Christmas Island (Indian Ocean).
INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6—J. Kennard Address.
GLASGOW UNIVERSITY ALCHEMISTS' CLUB, at 7.30—Dr. F. W. Ayton Isotopes.
INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.
ROYAL MICROSCOPICAL SOCIETY, at 7.45—M. T. Dennis A New Microscope—S. Dickinson A Simple Method of Isolating and Handling Individual Spores and Bacteria—Dr R. S. Clay and T. H. Court Two Microscopes made by G. Adams for King George III.
ROYAL SOCIETY OF ARTS, at 8—J. C. Goodison The Furniture of Hampton Court.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.
INSTITUTE OF CHEMISTRY (Annual General Meeting).
SOCIETY OF GLASS TECHNOLOGY (at Leeds).

THURSDAY, NOVEMBER 19

ROYAL SOCIETY, at 1.30—J. W. Pickering and R. J. Gladstone The Development of Blood Plasma. Part I. The Genesis of Coagulable Material in Embryo Chick—D. J. Scourfield On a new type of Crustacean from the Old Red Sandstone (Rhynie Chert Bed, Aberdeenshire). *Lepidocarpus Rhynianus*—J. R. Norman The Development of the Chondriocranium of the Eel (*Anguilla vulgaris*) with Observations on the Comparative Morphology and Development of the Chondriocranium in Bony Fishes—J. Needham and Dorothy Needham The Hydrogen-Ion Concentration and Oxidation-Reduction Potential of the Cell Interior before and after Fertilisation. A Micro-Injection Study of Marine Eggs—R. P. Armstrong Studies on the Nature of the Immunity Reaction—R. J. Lindford The Cytology of Tar Tumours—E. Ponder The Inhibitory Effect of Blood Serum on Hemolysis—L. Brull and F. Eichholz (a) The Effects of Calcium and Potassium Ions on Urine Secretion as studied in the whole Animal. (b) The Secretion of Inorganic Phosphate by the Kidney—F. Eichholz, R. Robinson, and L. Brull. Hydrolysis of Phosphoric Esters by the Kidney in vivo.

LINNEAN SOCIETY OF LONDON, at 5.—Dr H. G. Holden and S. H. Clarke: On the seedling structure of *Tilia europaea* L.—L. R. Crawshaw On Sponge Fishery.—Dr G. Claridge Bruce Recent Additions to the British Flora.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6—T. Carter The Engineer: his Due and his Duty in Life (Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduate Meeting) (at Watlington House, Adelphi), at 7.30—S. C. Vince and C. F. Gifford Modern Methods of Omnibus Chassis Overhaul.

CHEMICAL SOCIETY, at 8—Prof. E. C. O. Baly and R. W. Riding The Constitution of the Metallic Oxides—Prof. T. M. Lowry and I. J. Faulkner Studies of Dynamic Isomerism. Part XX. Amphoteric Solvents as Catalysts for the Mutarotation of the Sugars—Prof. T. M. Lowry and G. Owen Studies of Valency. Part V. Absorption Spectra of Halogen and Sulphonic Derivatives of Camphor. Origin of the Ketonic Absorption Band—Prof. T. M. Lowry and R. R. Ness Studies of Valency. Part VI. General and Selective Absorption of Halogen-Derivatives of Methane. The Origin of General Absorption—R. G. W. Norrish and G. Jones Studies of Valency. Part VII. Surface Polarity and the Reaction of Ethylene and Chlorine. The Effect of the Adsorbed Water Layer.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Laboratory Meeting) (at London School of Hygiene and Tropical Medicine), at 8.15—Demonstrations by Col. A. Alecock, Dr. A. Balfour, Dr. H. A. Baylis, Major K. K. Chatterji, Dr. A. Castellani, Dr. J. T. Dunneau, Dr. T. Jerke, Prof. R. T. Leiper, Mr. H. H. Newham, Dr. H. H. Scott, Lt. Col. H. Marrian Pettit, Dr. N. A. D. Sharp, Dr. J. G. Thomson, and Dr. C. M. Wenyon.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Branch)—H. W. Coulter. Some Hydraulic Problems.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch, jointly with Association of British Foundrymen (Scottish Section))—Discussion on Cast Iron for Diesel Engines.

INSTITUTION OF MECHANICAL ENGINEERS (North-Western Branch, Graduate Section) (at Manchester)—Lt. Col. E. Kitson Clark. Archaeological Engineering (Annual Lecture).

FRIDAY, NOVEMBER 20

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30—Prof. E. P. Stebbing Recent Progress in Indian Forestry.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6—Dr. A. Holt and others Discussion on Chemical Journals and Chemical Societies.

INSTITUTION OF MECHANICAL ENGINEERS, at 6—H. F. L. Orcutt Characteristics and Uses of Ground Gears.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7—A. C. Ranfield. Heliostatic Photography.

PHOTOGRAPHIC SOCIETY (at 4 Fetter Lane), at 7—Members' Evening.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30—G. E. Wills Dehydration of Tar.

SATURDAY, NOVEMBER 21

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (jointly with Institute of Mining and Mechanical Engineers) (at Neville Hall, Newcastle-upon-Tyne), at 3.
BRITISH MICROLOGICAL SOCIETY (at University College).

PUBLIC LECTURES.

SATURDAY, NOVEMBER 14

HORNIMAN MUSEUM (Forest Hill), at 3.30—R. A. Smith Aspects of Roman London. II.

MONDAY, NOVEMBER 16

GOLDSMITHS' HALL (E.C. 2), at 4—Sir Oliver Lodge The Link between Matter and Matter (Norman Lockyer Lecture).
UNIVERSITY OF LEEDS, at 5.15—Sir Charles F. Clowe Some International Aspects of Geography.

TUESDAY, NOVEMBER 17

KING'S COLLEGE, at 5.30—Miss Hilda D. Oakley The Philosophy of Aristotle. Philosophy of the Universe. Nature. The First Mover.
GREBBIAN COLLEGE (Basinghall Street), at 6—A. R. Hinks Meteorites and Meteor. (Succeeding Lectures on November 18, 19, and 20).

WEDNESDAY, NOVEMBER 18

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4—Dr. C. W. Saleeby The Role of Clothing in the Prevention and Arrest of Disease.
ROYAL SOCIETY OF MEDICINE, at 5.15—Sir Wilfred Beveridge Insects in Relation to Public Health (Chadwick Lecture).

THURSDAY, NOVEMBER 19

BEDFORD COLLEGE FOR WOMEN, at 5.15—Sir Robert Witt. Eighteenth-Century Art.
DYER'S HALL (Dowgate Hill), at 6—Dr. E. F. Ehrhardt The Patent Law as it affects the Dye-making and Dye-using Industries.

FRIDAY, NOVEMBER 20

ROYAL SOCIETY OF MEDICINE, at 5.30—Dr. Howarth The Slaughtering of Animals for Human Consumption (Benjamin Ward Richardson Memorial Lecture).

SATURDAY, NOVEMBER 21

HORNIMAN MUSEUM (Forest Hill), at 3.30—G. C. Robson: Animal Life in the Depths of the Sea.



SATURDAY, NOVEMBER 21, 1925.

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The Norman Lockyer Memorial Lecture.

ON Monday last, the first Norman Lockyer lecture, under the auspices of the British Science Guild, was delivered by Sir Oliver Lodge in the hall of the Goldsmiths' Company, his subject being "The Link between Matter and Matter." It is fitting that the Guild should thus honour the memory of the man who, more than any other, was responsible for its formation, and no happier choice for the first lecturer could have been made than that of Sir Oliver Lodge. Lockyer was essentially a man of wide vision; his mind sought instinctively for generalisations. A fact was to him only of importance in so far as it was related to the general principles which underlie all facts. He was not content with a laboratory; he would have an observatory. He was not content even with an observatory; he would have a theory which would embrace all the revelations of the laboratory and the observatory and bind the whole physical universe into a single entity. The key to Lockyer's scientific career is to be found in this overpowering tendency to generalise, and no one who is not to some extent under the dominance of the same tendency can rightly interpret the apparently erratic course which his genius led him to pursue.

Sir Oliver spoke briefly of his personal association with Lockyer, which began so far back as the year 1873 when Lockyer was working in rooms generously placed at his disposal by Frankland in the new School of Science at South Kensington. He then referred to the discovery of helium, which, for twenty-six years after Lockyer had found it in the sun, remained a mere spectroscopic curiosity, but which, since Ramsay's isolation of the element from cleveite, has been instrumental in bringing about some of the most important advances of modern physics and astronomy. "Thus it is," he said, "that little discoveries, at first apparently isolated and without obvious meaning, turn out not to be little at all, but fundamentally important, being systematised by future workers until they furnish the clue to a magnificent series of discoveries about the constitution of matter." Lockyer, however, did not wait for future workers. He had his ideas about the constitution of matter long before helium was generally admitted to exist even in the sun, and he was fundamentally right.

Sir Oliver went on to speak of the human aspect of Lockyer's work. "Lockyer's work and speculations were never really remote from humanity; he kept before himself continuously, and eloquently urged upon others, the necessary bearing of all scientific discovery on human and social progress." It was the conviction that science was the chief factor in the material progress

of nations that led him to found the British Science Guild, and to choose for the subject of his presidential address to the British Association in 1903, not the development of his own individual researches, wide as they were, but the importance of science to national progress—"The Influence of Brain-Power on History," as he called it. The same conviction was an important factor in his determination, in the year 1869, to inaugurate a new journal of science—*NATURE*—in order that the progress of science might be followed by all, and not only by those actively engaged in scientific pursuits.

Coming to the subject indicated by the title of his address, Sir Oliver defined "the link between matter and matter" as "the impenetrable uniting ingredient, or cosmic unit, which connects the otherwise dissociated or dissevered atoms of matter, and enables them to act on each other even from a distance. This ingredient . . . is essentially 'radiation,' that is to say, a disturbance in the ether, or in space, which travels at one absolute velocity, which journeys without loss or dissipation of energy, and produces even at enormous distances its singular and striking results." This link between matter and matter is required to explain gravitation and the propagation and chemical action of light. One of its surprising characteristics is the power—commonly known as photo-electric action—"of unlocking the atom and enabling it to fling away one of its constituent electrons." Sir Oliver raised the question "whether the energy of . . . photo-electric emission is applied instantaneously by the radiation stimulus, or whether it is gradually accumulated in the atom up to some critical point, when it can wait till radiation of the right frequency pulls the trigger." He is of the opinion that there is something to be said for the second alternative, and that the discontinuity of the quantum might be found in the discontinuity of atomic construction rather than in "the otherwise demonstrated continuous activity or continuity of etheric radiation."

Radio-activity is another example of an apparently spontaneous process, but this also might really be due to the impact of radiation of critical frequency. "I believe that some people, I for one, are beginning to suspect that all atomic changes are due to radiation. And I would even venture to surmise that this etheric mode of inter-communication, the transmission of waves from one piece of matter to another, has more influence on ordinary, the most ordinary—even mechanical—processes than we are yet prepared to admit." The pressure of light, for example, has lately been found in certain circumstances to be very large and of cosmic importance—for instance, in the interiors of stars. Sir Oliver was not prepared to say whether or

not it ought to be taken into account in the intimate structure of atoms. The stability of Bohr's atomic orbits was a fact which had not yet been accounted for, and our aim should be to explain this and other facts on dynamical principles—"perhaps not the ordinary dynamics but etherial dynamics."

Some attempt has already been made to assimilate matter with radiation "by the very unlikely path of thermodynamics." Radiation has been treated almost like a gas, and results have been arrived at which, though they have not yet been rationally accounted for, are nevertheless true. Thus we can speak of the "temperature" of space or of radiation, and we form the conception of matter in thermodynamic equilibrium with radiation. Developing the conceptions thus generated we arrive at the quantum. "If the energy could be absorbed or emitted continuously, all the energy of matter would go into the ether, and the universe would fade away. The effect of discontinuous emission and absorption saves the universe from destruction, and makes the planet possible."

These are all fundamental considerations, and it is characteristic not only of Sir Oliver Lodge but also, to some extent, of the age in which we live, that they should be so. We are deeply involved now in problems which, fifty years ago, could not be said to have existed; they are expressible only in terms of conceptions which had not then been formed. We see now no clear dividing lines between mechanics, physics, chemistry, geology, and astronomy. None of these departments of science is complete without the others, and it is becoming increasingly clear that the physicist can no longer exclude even the principles of metaphysics from his field of inquiry. Our age is prospective; it builds the unity of the cosmos. But in Lockyer's day things were far otherwise. The progress of that time, very real though it was, lay mainly in the discovery of isolated facts, which were interpreted in the light of old and long-established principles. "Our age is retrospective," wrote Emerson; "it builds the sepulchres of the fathers."

Into this age, with its rigid formulation of the fundamental bases of a number of discrete sciences, Lockyer came with his iconoclastic, unifying mind. He was one born out of due time into a generation unprepared for his message. Much of his work which now suggests itself as so obvious a line of research to follow, and which the mistakes present themselves so clearly to our view, must be seen against the background of the prevailing ideas of the time in order to be estimated at true value. Although Kirchhoff had shown in 1859 how the solar spectrum was to be interpreted by laboratory experiments, no one before Lockyer (in 1869) combined the work of the observatory with that of the laboratory.

Because the atom was held to be indivisible, no one but Lockyer believed that physical conditions could influence the spectrum of an element. Lockyer at once cut across current ideas by proving the contrary in the laboratory and pointing to the spectra of the sun and stars for further evidence, not hesitating for a moment even to declare the atoms to be dissociated in order to explain his observations. Although in 1859 Darwin had finally established the conception of evolution in biology, no one before Lockyer spoke of the evolution of the chemical elements and of the stellar universe. It is easy, with our wider knowledge, to point to his mistakes in the formulation of his conceptions, and to the "obstinacy" with which he held to details now finally discredited. It is not so easy to estimate how great an influence his courageous individualism and breadth of vision have had in preparing the way for the relative enlightenment of our own day.

"All Lockyer's information," said Sir Oliver, "was derived from a study of radiation. The chromosphere, the partitioning of the solar atmosphere into regions, and the observation of red flames without an eclipse—represent the broodings of his genius on the information brought him by tremors or quivers in the ether of space." That is true, but Lockyer did not explicitly concern himself with radiation at all. To him it was not the link which bound matter to matter; it was the instrument which told him what he wanted to know about matter itself. Of the two great physical entities (or must we now call them one?) matter and energy, he confined his attention to matter alone. Perhaps with his mental and physical equipment he could have done no other, yet it appears that it is to the ether and radiation that we must now look for the completion of Lockyer's ideas. His two great generalisations—the dissociation hypothesis and the meteoritic hypothesis—were in error mainly in so far as they ignored the radiation factor. He saw that atoms might be dissociated, but he did not conceive that absorption of radiation was the agency through which the dissociation was brought about, and herein lies the relative barrenness of his view when compared with its modern equivalent, ionisation. He saw also that stars with similar spectra might be very different in physical state, but he did not imagine that the difference was related to the pressure of radiation and the generation of etherial energy from mass, which is the source of the fruitfulness of our latest conceptions. He could not, of course, have foreseen these things. Essential as they were to the completion of the ideas he held, he had no data from which they could have been suspected; yet, single-handed and faced by many obstacles, he came nearer to the conceptions which we now hold than any of his contemporaries. H. D.

A History of Mathematics.

History of Mathematics. By David Eugene Smith. Vol. 2: *Special Topics of Elementary Mathematics.* Pp. xii+725. (Boston, New York and London: Ginn and Co., 1925.) 21s. net.

THE two volumes of this history (the first of which was noticed in NATURE of November 15, 1924) deal with the subject from two different aspects. The first volume, described as a "General Survey," is devoted to showing "the growth of mathematics by chronological periods with due consideration to racial achievements," and to "relating the development of the science to the development of the race, revealing the science as a great stream rather than a static mass, and emphasising the human element." Details of the lives of mathematicians, their dates, and their relation to contemporary history accordingly find their place in the first volume, which in this respect follows the plan adopted by most of the writers of histories of mathematics, both English and foreign. The first volume is thus comparable with such useful and popular histories as those of Rouse Ball, Cajori, Günther-Wieleitner, and others. It contains, however, features of additional interest in the many portraits of mathematicians, pictures of mathematical instruments and illustrations of their use, facsimiles of pages from printed books and manuscripts, which are given in their proper places.

The second volume now before us, called the "Topical Survey," deals with special topics of elementary mathematics. (We may perhaps observe incidentally that, as the sub-title of each volume limits its scope to elementary mathematics, it might have been better if, with the view of avoiding misapprehension, the whole work had been called a "History of Elementary Mathematics," rather than a "History of Mathematics" simply.) That is to say, the history is here arranged according to subjects. As the author remarks in the preface:

"The teacher of arithmetic will now see, in three or four chapters, a kind of moving picture of the growth of his subject,—how the world has counted, how it has performed the numerical operations, and what have been the leading lines of applications in which it has been interested. In geometry he will see how the subject arose, what intellectual needs established it so firmly, what influences led to its growth in various directions, and what human interest there is in certain of the great basal propositions. In algebra he will see, partly by means of facsimiles, how the symbolism has grown, how the equation looked three thousand years ago, the way its method of expression has changed from age to age, and how the science has so adjusted itself to world needs as now to be a necessity for the average citizen instead of a mental luxury for the selected few."

Here Prof. Smith has no predecessors in English and only one comparable one in German, so that the work was well worth undertaking. Of his German predecessor's work, the "Geschichte der Elementar-Mathematik in systematischer Darstellung mit besonderer Berücksichtigung der Fachwörter," by Dr. Johannes Tropfke, Prof. Smith says truly that it is the best history of elementary mathematics. The first edition of 1902-3 was in two volumes of 322 and 496 large pages respectively; but the new edition, in seven volumes or parts issued between 1921 and 1924, is greatly enlarged and improved, and runs to a total of 1268 pages.

With such a model before him, Prof. Smith's difficulty must have been to compress his material, with the addition of illustrations, facsimiles, etc., into a volume of 725 pages of smaller size. It would have been comparatively easy to write a smaller volume containing only the most salient details, served up to suit the palate of the ordinary non-expert reader. But Prof. Smith's object is different; he wishes to supply the professional teacher of mathematics with all that he needs in order to be able to teach his subject with a proper sense of perspective derived from a real knowledge of the manner of its evolution. The difficulty is to give just sufficient details and no more, and not to leave out anything which is essential to make the subject comprehensible. In the general compression which Prof. Smith has found necessary, some topics suffer unduly. Logarithms, for example, are disposed of in the all too short space of ten pages. We could have wished to have a fuller statement of what Napier's logarithms exactly were, how evolved, and how related to the so-called Napierian or hyperbolic logarithms and also to Briggs's system. On the other hand, there is a very useful chapter on the history of the calculus as a separate subject.

Every effort has been made to produce a readable as well as a comprehensive book. A long chapter is devoted to elementary problems (including mathematical recreations, commercial problems, magic squares, and the like); another to measure (weight, length, capacity, time, etc.). In the second volume, as in the first, there is a wealth of interesting illustrations, facsimiles, etc., and a valuable collection of references in the notes. The labour involved in the whole work must have been prodigious, and we can only wish for it the success which it deserves.

It is inevitable that in a book containing such masses of detail there should be mistakes which have escaped detection, some being doubtless mere printer's errors. On p. 287, Pamphila, a historical writer of the first century A.D., is quoted as Pamphilus. On p. 291, "Lucian (second century), the scholiast to the Clouds

of Aristophanes" should be "Lucian (second century) and the scholiast, etc." On p. 304 it is conveyed that Hippocrates of Chios showed how to square one type of lune only, whereas he actually squared three out of the only five types of lune which can be squared by means of the geometry of the straight line and circle. On p. 307 (note) Rose's edition of Vitruvius is cited as giving $4\frac{1}{2}$ ft. as the diameter of a wheel of circumference $12\frac{1}{2}$ ft.: this should apparently be $4\frac{1}{6}$ ft., making the value of π assumed by Vitruvius to be 3 and not "less than 3." On p. 313, Archytas is said to have solved the problem of the two mean proportionals by means of "two cylindric sections"; the surfaces actually employed by Archytas were three, namely, a right cone, a cylinder, and a tore or anchor-ring with inner diameter nil. $\xi\kappa\theta\epsilon\sigma\iota\varsigma$ (p. 496) is said to be a "selling out," where "setting out" is what is meant. The strangest case is that in note 1 on p. 615 referring to Ptolemy's division of the circumference of a circle into 360 parts and of the diameter into 120 parts. The note states that the parts were " $\tau\rho\acute{\eta}\mu\alpha\tau\alpha$ (trēmata, literally 'holes' and hence the holes, or pips, of dice)." We confess to being baffled as to the source of this statement; the word actually used by Ptolemy is $\tau\mu\acute{\eta}\mu\alpha\tau\alpha$, which simply means "segments," i.e. the parts into which a line is "cut" ($\tau\acute{\epsilon}\mu\omega$).

The Ravages of Sea-Water.

Department of Scientific and Industrial Research. Deterioration of Structures of Timber, Metal and Concrete exposed to the Action of Sea-Water: Fifth (Interim) Report of the Committee of the Institution of Civil Engineers. Edited by P. M. Crosthwaite and Gilbert R. Redgrave. Pp. vii+65+8 plates. (London: H.M. Stationery Office, 1925.) 3s. 6d. net.

THE Committee of the Institution of Civil Engineers which has been investigating the deterioration of structures of timber, metal, and concrete in sea-water since 1916, with the assistance of grants from the Department of Scientific and Industrial Research, has prepared a fifth interim report which has recently been published. It consists of a brief review by the Committee of ten reports included in the publication, together with the reports themselves and a number of abstracts received from correspondents.

During the past year further examinations have been made of the steel and other specimens exposed for corrosion tests at Auckland, Colombo, Halifax, Nova Scotia, and Plymouth, and detailed reports of the present condition of the steel bars, accompanied in some cases by photographs, have been received from the engineers in charge. A comparative statement has been drawn

up by Mr. Carothers for Mr Savile, the Civil Engineer-in-Chief of the Admiralty, which presents in small compass the chief features of these periodical inspections in a form convenient for study. It is pointed out in certain of the reports that, owing to the constantly increasing growth of marine organisms and the heavy incrustation which is now attached to some of the frames, it is becoming exceedingly difficult at the present time to form a correct judgment of the condition of the metal work and bars; nor will it be possible in these cases to do so until they are taken out for final examination and measurement. Dr Newton Friend's researches on preservative coatings for ferrous metals have been continued. The specimens tested are at Southampton, under the charge of Mr. Wentworth Shields.

Various experiments bearing on the protection of timber are still being prosecuted, while a further number of specimens impregnated with different poisons have been exposed during the year at Lowestoft; and certain timbers injected with creosote and D.M. (an arsenical organic compound) have been sent to Colombo, as the ravages of the *Teredo* have been found to be very severe in that port. Prof Berger deals in his report with the changes made in the exposure of the specimens at Lowestoft. Specimens of wood tested at Plymouth have been more resistant than those at Lowestoft, and the experience there indicates that remarkable protection was secured by 2.2 per cent of carbazole. A full account is given of the mechanical tests on sixteen varieties of Colonial timbers specially procured for this purpose from Australia, New Zealand, and Ceylon. An abstract has been prepared by Mr Hamer reporting on the specimens of local timbers under exposure at Auckland. It would appear that none of the preservatives employed has altogether prevented the attacks of marine borers, though in some instances the specimens have shown considerable powers of resistance.

It was stated in the previous annual report that in consequence of defects found in a concrete building erected by the Admiralty and exposed to the action of sea-water, a thorough investigation of all similar structures controlled by the Admiralty had been agreed upon. The results of this inquiry are set forth in the present report. It would appear that in some cases considerable injury was found in the upper portions of certain of the jetties, especially on the underside of deck beams. In order to remedy these defects and to avoid similar imperfections in future, certain precautions are recommended for executing works in reinforced concrete that are to be exposed in the sea or in the neighbourhood of high-water mark. A paper on the disintegration of cement in sea-water, contributed to the American Society of Civil Engineers by Messrs. Attwood and

Johnson, forms the subject of an abstract in the present volume. Dr. Ternent Cooke, who had been requested by the Harbour Board of South Australia to examine certain samples of decayed concrete prepared for a partially constructed breakwater, recently published an article on the subject, of which an abstract has been prepared for the volume. He states that it would appear from the chemical examination that organic matter from beds of decaying seaweed permeated the outer layers of the concrete and caused disintegration. The lime was then leached out and the superficial layers of the concrete were gradually decomposed.

The Department of Scientific and Industrial Research having intimated that its grants in future must be conditional on half of the expenditure being hereafter met from other sources, a number of Port and Dock Authorities were invited to contribute to a fund for five years. A very gratifying response was made to this appeal and a sum of 738l was received during the past year. A considerable portion of this total has been promised for a series of years.

Huygens' Discovery of Saturn's Ring.

Œuvres complètes de Christiaan Huygens Publiées par la Société Hollandaise des Sciences. Tome Quinzième: Observations astronomiques, système de Saturne, travaux astronomiques, 1658-1666. Pp. iv+619. (La Haye: Martinus Nijhoff, 1925.) n p

AFTER an interval of nearly five years (vol. 14 was reviewed in *NATURE*, vol. 107, p. 4) another instalment of this magnificent edition of the works of Huygens has made its appearance. It contains his astronomical observations and his publications on Saturn. Unfortunately the manuscripts recording the observations (1657-1694) are far from being complete. The chief source is a MS. called "K," in which Huygens evidently intended to copy all his observations from the originals. But in some cases the original records are not now extant, while there are signs that some of the records in still existing MSS., which have been copied into "K," are not themselves originals. In particular a "parvus libellus" containing observations earlier than December 1657 is lost; but the letters of Huygens and his book on Saturn have enabled the editors to draw up a supplementary list for the years 1655-1690. There were, however, long periods of almost complete inactivity as regards observing, due probably to ill-health or other work, although remarks found here and there in his letters show that Huygens had not very much sympathy with enthusiastic observers like Hevelius or Cassini. During his long residence in Paris, he observed occasionally at the king's library or at the observatory.

The telescope with which Huygens found the Saturnian satellite, now known as Titan, and the true explanation of the strange appearance of Saturn, had a focal length of about 11 feet, an object glass of 2.7 inches aperture (still preserved at Utrecht), and magnified 50 times. It was only in use for about a year, and was then superseded by another of about 23 feet f.l. and 4 inch o.g., made by Huygens and his brother Constantin, while others of about the same size were also made and used. In 1682, after his final return from Paris, Huygens made and tried to work with enormously long telescopes, but like everybody else found them too difficult to manage. Most of the glasses were kept together until 1754, when they were sold by auction and scattered. Seventeen of them can still be identified, of which three belong to the Royal Society, while the rest are at Leyden or Utrecht; but only five were made by Christian Huygens, the rest by his brother.

The observations printed in this volume fill 109 pages, and are illustrated by facsimile copies of Huygens' sketches. Nearly all of them are studies of the planets and their surface markings, and naturally most of them refer to Saturn. So early as 1659, Huygens considered it very probable that Mars rotated in about 24 hours. How some of his sketches have turned out to be very valuable for the exact determination of the period of rotation of Mars, is well known. He made attempts to measure the diameters of the planets in various ways, by comparing them with the breadth of a lamella at the focus or by an arrangement similar to W. Herschel's lamp-micrometer. But his search for satellites to the planets turned out to be of more value, as on March 25, 1655, he discovered a satellite of Saturn (Titan), the first satellite found since Galileo announced that Jupiter is accompanied by four satellites. The discovery was published in a small pamphlet of a few pages ("De Saturni Luna observatio nova"), which has now become so extremely rare (if it exists anywhere) that the editors have had to reprint it from the old edition of Huygens' "Opera Varia" (1724).

The fact that the satellite moved in a plane passing through the mysterious "handles" of Saturn, confirmed Huygens in the belief which he reached in the winter of 1655-1656, that these strange and variable appearances were due to a very thin, broad, plane ring surrounding the planet but detached from it. After the manner of those days, he announced his discovery in an anagram at the end of the pamphlet on the satellite, "in order that if any one thinks he has found the same thing, he will have time to announce it, so that it may not be said that he has borrowed it from us or we from him." The challenge was accepted by three people. by Hevelius, who thought that

Saturn was a spheroid to the ends of which were attached two handles; by Roberval, who assumed the planet to be a sphere surrounded by vapour except at the poles; by Hodierna, who believed Saturn to be shaped like an egg, with two non-luminous spots near the ends of the longest axis. In his book "Systema Saturnium" (1659) Huygens did not find it difficult to show how impossible it was to account for the varied appearances of Saturn by any of these hypotheses, while he showed in detail how well his own theory agreed with all the observations made during the fifty years elapsed since the invention of the telescope. But a determined attack on the theory was made in 1660 by Eustachio Divini, whose little book on the subject was known to be inspired by the Jesuit Honorato Fabri. As it was difficult of access to people in the Netherlands, Huygens reprinted the whole of Divini's attack in the reply which he published in the same year; and some years after he had the satisfaction to learn that Fabri had recognised the truth of the ring-theory.

In addition to the above-mentioned writings, the volume under review contains a number of appendices to them, extracted from Huygens' notebooks, and dealing with various minor astronomical problems. Among these may be mentioned an approximate determination of the orbit of a satellite of Saturn from two observations, occasioned by Cassini's discovery of Iapetus and Rhea.

By the many hitherto unpublished memoranda, by the valuable, detailed introductions, by the French translations of the texts of the books published by Huygens himself (no doubt welcome to many readers), and last, but not least, by the beautiful paper and print, this edition forms a monument worthy of the great Dutch astronomer.

J. L. E. D.

Guy Patin and his Times.

Guy Patin and the Medical Profession in Paris in the XVIIIth Century. By Dr. Francis R. Packard. Pp. xxii + 334 + 10 plates. (London: Oxford University Press, 1925.) 18s. net.

THE present volume by Dr. Francis Packard, whose "Life and Times of Ambroise Paré (1510-1590)" was noticed in our columns on March 3, 1923, p. 281, has been reprinted with additions from the "Annals of Medical History," of which he is the editor. The work is divided into nine chapters, commencing with a historical foreword which contains an account of contemporary politics, the later chapters dealing with Patin's education, his home life and literary interests, his opposition to cinchona and antimony, and his relations to the surgeons, barber surgeons and apothecaries. A special chapter is devoted to a description

of the Paris medical faculty in which Patin's life interest was centred. "No praise," says Dr. Packard, "was too fulsome for those who furthered its cause and no abuse too savage for those who dared to attack it." Of particular interest are the pages concerned with Patin's relations to Molière, his controversy with Théophile Renaudot, the gazetteer and quack, and his quarrel with the physicians of Montpellier.

Guy Patin was born in 1601 at a village in Picardy, graduated in medicine at Paris in 1627, was elected dean of the faculty of medicine in 1650, and died in 1672, so that his active life covered the greater part of the seventeenth century. The historic value of his letters, on which his fame rests, has been impugned by such critics as Bayle and Voltaire, but Dr. Packard rightly maintains that as pictures of the life of the day they are invaluable. It must be remembered that they were never intended for publication.

Patin was an upholder of the old Greek medicine as represented by Hippocrates and Galen, and a bitter opponent of the new chemical remedies which had been introduced by Basil Valentine, Paracelsus, van Helmont, De Mayerne, and others. Like most of his contemporaries, Patin was firmly convinced of the value of copious bloodletting and free purgation in diseases of all kinds. "There is no remedy in the world," he said, "which works as many miracles as bleeding."

Dr. Packard points out that though Patin never became in the strict sense of the term one of the physicians to the Court, his letters are full of references to medical matters connected with the Court and of tales of physicians honoured by the king.

Patin's scholarly tendencies are illustrated not only by his interest in the history and literature of his profession, but also by his lively concern in general literature, as shown by the allusions in his letters to new editions of Vossius, Lipsius, Casaubon, Scaliger, Grotius, and so on.

The work is illustrated by contemporary portraits of Guy Patin, his son Charles Patin, professor of medicine at Padua, of whom Voltaire said that "his works were read by scholars, while his father's letters were read by the idle," Cardinal de Richelieu, Cardinal Mazarin, Jean Riolan the Younger, Gabriel Naudé, the librarian of Cardinal Mazarin and author of a well-known book on the history of magic, and François Guénault, physician to Louis XIII. and, owing to his advocacy of antimony, one of the men whom Patin most detested. In the bibliography which is appended, special attention is given to the articles by Chereau, and the editions of the letters published by Pierre Pic and Paul Triaire.

Dr. Packard's book is a scholarly achievement, written in an attractive style, and gives an admirable picture of French medicine in the seventeenth century.

Our Bookshelf.

Die Süsswasserflora Deutschlands, Oesterreichs und der Schweiz. Herausgegeben von Prof. Dr. A. Pascher. (Jena: Gustav Fischer, 1913-1925.)

THE series of volumes comprised in Pascher's "Süsswasserflora" first began to appear in 1913 and is now rapidly approaching completion. Those so far published deal with the Flagellatæ, the Isokontæ (apart from Volvocales and Desmidiaceæ), the Bacillariales, Heterokontæ, Phæophyceæ, Rhodophyceæ, Charales, and Bryophyta. The work deserves to be more widely known among those interested in the study of freshwater Algæ, for since each volume is compiled by a specialist on the particular group, it usually embodies the results of critical work and is strictly up-to-date. It is far more than a popular summary of what is known. At the same time, keys for the determination of genera and species are numerous and as a rule carefully prepared, so that even a relative novice is put in the position of being able to identify common forms both speedily and easily.

As with all such collective publications, the treatment is somewhat unequal. Perhaps the most disappointing was the volume on Zygnematales by Borge, which, both as regards text and illustration, was altogether too scanty. On the whole, however, one can have nothing but praise for the care that has been bestowed upon the text, whilst the majority of the volumes are excellently illustrated, nearly every species being figured. Of particular value are the early volumes on Flagellatæ by Pascher and that dealing with Heterokontæ and the Red and Brown Algæ just published, which contain a mass of information here collected together for the first time.

Although ostensibly a freshwater flora of Central Europe, several of the algal groups are treated almost *in extenso*, all the genera and a great majority of the species being mentioned, even such as are at present only known from regions quite remote from Central Europe. In this respect, however, there appears to be no uniform plan, and the result is somewhat incongruous. Especially in some of the volumes more care might have been expended on the preparation of the index, which is of special importance in a taxonomic work. The price of the different volumes (averaging about four shillings) is very reasonable.

As the above was passing through the press, a thick volume on Cyanophyceæ by Geitler has been published. Algologists will welcome the detailed systematic treatment of this difficult group. The only defect is a tendency to multiply genera rather unnecessarily, whilst the introductory matter is based on a somewhat one-sided consideration of the literature.

F. E. FRITCH.

Biology and Human Life. By Benjamin C. Gruenberg. Pp. xiv + 592 + xi. (Boston, New York and London: Ginn and Co., 1925.) 7s. 6d. net.

IN Great Britain, biology is taught in schools, usually only in secondary schools, mainly from the examination point of view, to pupils who intend to pursue the subject further at a university or are preparing for a medical career. The majority of pupils, and particularly those in elementary schools, receive little if any

instruction in biology. The author of this book is convinced of the importance of a knowledge of biology to every member of the community, and no biologist at least would controvert his statement that "boys and girls who look forward to an early entrance upon occupational activities and the responsibilities of earning and spending money have as much need for the study of biology as have those who plan to go to college or the professional schools." This book is designed to meet this pressing need, and, if somewhat novel in its treatment of the subject, is so planned as to make it a living and vital one by special emphasis on the applications of biology to human affairs at all points.

After a brief introduction, all too brief we fear, to general biology, the main part of the book is divided into two sections headed the Biology of Health and the Biology of Wealth. In the first of these sections the author gives what is practically an introduction to human physiology, public health, hygiene, and the biology of disease, treating man first as an individual and then as a member of the community. The second section is a short survey of the field of economic zoology and botany with special reference to those animals and plants which are of importance to the general economics of the human race. The book is written in an almost breezy style, and the interest of both pupil and teacher constantly stimulated by questions designed to emphasise or enlarge on the special points of each chapter. The general plan of the book can be recommended as a good one for use by teachers in elementary schools, for, presented in this way, the pupil cannot fail to realise the fundamental importance of biology to himself personally and individually, and consequently to every member of the community in which he lives.

Geology in its Relation to Landscape. By Prof. Junius Henderson. Pp. vii + 152 + 30 plates. (Boston, Mass.: The Stratford Co., 1925.) 2.50 dollars.

PROF. HENDERSON has enriched the literature of a picturesque subject by his attractive and almost romantic treatment. His book is informal, and though it will teach the geologist nothing new, it is of the inspiring kind that, falling into the right hands, will make new geologists. Any one of ordinary education, and an interest in scenery, will be able to follow these pages with ease and pleasure. The book is beautifully printed and illustrated, and the author amplifies his own literary gifts with numerous poetical quotations.

After five introductory chapters dealing with geological processes and structures, there follow longer chapters devoted in turn to rivers, waterfalls, lakes, the oceans, glaciers, mountains, and volcanoes. The final chapters are concerned with geology in relation to vegetation, animal life and civilisation, and these will perhaps be of most interest to readers already familiar with the physical evolution of landscape, for they show, with many a light and happy touch, how geological factors have controlled man's environment, and how they have been turned to his service. The book may be warmly recommended, in particular to teachers and students of geography, and in general to the wider public who find in scenery one of the leading attractions of a holiday.

The National Physical Laboratory. Collected Researches. Vol. 18, 1924. Pp. iv + 456. (London: H.M. Stationery Office, 1925.) 17s. 6d. net.

THIS volume is a reprint of twenty-one electrical papers which have issued from the National Physical Laboratory and been published in the proceedings of scientific societies or in the technical press during the years 1919-24. About half of them deal with problems which have arisen in some branch of the electrical industry, and the other half with improvements in the methods and instruments used in standard measurements. In the first category are investigations on the magnetic properties of silicon irons, the behaviour of intervalve transformers, the electrical resistance of overlapping joints in conductors, the rating of cables for intermittent loads, the improvement of carbons for searchlights, and the use of a cube whitened inside in the photometry of electric lights. In the latter group are investigations of new methods of calculating self and mutual inductances of coils; on the effects of eddy currents on measuring instruments, on the best methods of measuring the intensities of radio signals, on the properties of the triode valve, on the measurement of the earth's field by an electrical method, and on an electrostatic voltmeter for accurate measurement. Many of these investigations have been carried out for Government Departments the consent of which has had to be obtained before the results could be made public. The whole add to the credit of the Laboratory and its staff, and make one wonder how the electrical industry managed to advance at all in the days before the National Physical Laboratory came into existence.

The Nature of Enzyme Action. By Sir W. M. Bayliss. (Monographs on Biochemistry.) Fifth edition. Pp. viii + 200. (London: Longmans, Green and Co., 1925.) 9s. net.

THE fact that the monograph has reached its fifth edition shows that it occupies a definite place in modern biochemical literature, and it seems almost superfluous to state that it presents an excellent account of our knowledge of the nature of enzyme action. Its very excellence, however, makes us realise the loss which science has suffered in the death of Sir William Bayliss. The manuscript was brought up-to-date by the author before he was overtaken by his illness, and has been prepared for the press by his son, without any attempt to include the work of the last two years. The earlier chapters consider the physical and chemical properties of enzymes and their methods of preparation and investigation, the central connecting thread being that enzymes act in the same way as catalysts of known chemical constitution. After a chapter on the velocity of reaction, the author passes on to consider their mode of action, and shows himself to be an advocate of the view that enzymes act by adsorption of their substrates so that the reacting substances are brought into a state favourable for the rapid progress of the reaction; the arguments for this view are fully and clearly presented. In succeeding chapters, co-enzymes, antienzymes, and zymogens are considered, and a short account is given of oxidation processes: doubt is thrown upon the existence of a number of so-called "antienzymes." The work is concluded by an extensive bibliography.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Blindness of Cave-Animals.

PROF. MACBRIDE has contributed a chapter to a volume of essays published by Messrs. Blackie and Son which professes to treat of evolution "in the light of modern knowledge." Prof. MacBride's chapter is headed "Zoology" and sets forth a statement of older as well as novel observations and experiments made by other workers which lead him to conclude that the evolution of organic form in plants and animals has been caused—mainly if not entirely—by "use and disuse," as held by Lamarck—not in the light of modern knowledge—but more than one hundred years ago.

Prof. MacBride cites the experiments and records of others. Consequently his paper has not the significance it would have, were he relating his own researches. I submit that judgment should be suspended with regard to Kammerer's results as to salamanders and toads until they have been repeated: for as Mr. J. B. S. Haldane points out (in his valuable article, "The Causes of Evolution," in the Annual of the Rationalist Press Association, 1926, p. 56), in the majority of similar cases brought forward in the past, critical repetition has proved fatal to the conclusions drawn from them.

It is especially in regard to the reduction of the eyes of certain cave-dwelling animals to vestiges, a process accepted by Prof. MacBride (as by Darwin in 1859) as due to the "disuse" of these organs consequent upon the absence of light from their environment, that I wish to make some criticism. Certain cave-animals are known, as he states, to be allied closely to normal species which live outside the caves at no great distance. The cave species living in the dark are either devoid of eyes altogether or have their eyes reduced to vestiges. Darwin, as stated by Prof. MacBride, assumed that the eyes of animals living in darkness failed to grow to their proper size owing to lack of use, and that this diminution in size was heritable—in short, that the effects of disuse were inherited. Without more ado, Prof. MacBride accepts this conclusion, declaring that other explanations of this phenomenon, which he does not cite with one exception, were "amazing." The exception is Weismann's theory of "panmixia," which he discusses and rejects.

I wish now to point out two important defects in "the disuse theory" of blind cave-animals as stated by Prof. MacBride, which seem to me to render his position untenable.

(1) We have no record of experimental work showing that the eyes of animals bred in the dark are reduced in size as compared with the eyes of the same species bred in normal conditions. Nor have we any records of the exact changes, if any, in size or character of the various parts of the eye when an individual animal or a series of successive generations has been born and reared in the dark as an experiment. No such experiment has been recorded in regard to any one species of vertebrate, nor in regard to any insect, crustacean, mollusc, or jelly-fish—in each of which peculiar and elaborately constructed eyes are found. Nor, again, do we possess any extensive and well-considered account of "congenital defects" of the visual organs in any one animal or in representative animals from different classes to which

we can refer for comparison, except in the records of human pathology. Again, our knowledge is very defective, especially as to microscopic details, in regard to the actual condition of the eye in blind cave-animals, as also in regard to that of the eye of blind deep-sea fishes and crustacea. Darwin seems to have regarded diminution in the size of the eye as the important matter; but such things as the condition of the retina and of the lens-like transparent structures, and again of focussing and light-screening parts of the eye, must each have its own decisive importance.

The absence of experiment in the matter has recently to some extent been removed by the American observer Payne (quoted by Mr. J. B. S. Haldane, *loc. cit.*). "Mr. Payne bred *Drosophila*, a fly which tends to move towards light, for seventy-five generations in darkness. At the end of that time no visible change had occurred in the eyes, and when 1000 such flies were given the opportunity of moving towards a light no change was found from the normal either in the proportion which moved within a minute, or in the average rate at which they moved." The majority of the experiments on the inheritance of the effects of use and disuse lead, writes Mr. Haldane, to equally negative results. Apparently the American observers have not yet had time to go into the question of the production of any departure from the normal in the minute structure of the eye as distinct from its physiological activity. In the actual state of knowledge we are not warranted in assuming that "darkness-disuse" produces a permanent change of structure in the disused eye.

(2) I now come to my second objection to Prof. MacBride's assumption of the truth of the disuse-theory of the blindness of cave-animals. It is this: we are not compelled to assume the inheritance of the effects of disuse in this case as the only probable explanation of the facts, since the theory of natural selection sufficiently accounts for the production of blind species of cave animals. Mr. Darwin in co-operation with Mr. Wollaston ("Origin of Species," chapter v.) pointed out that the wingless beetles of Madeira owe their relatively great abundance there (and in other sea-girt islands) to the fact that beetles with normal wings and normal powers of flight are continually caught when flying by the heavy winds and blown out to sea and destroyed. Those individuals with congenitally defective wings—a defect known to occur normally in a certain proportion of beetles of various species—will lie close to the ground and thus escape the fate of those caught by the winds when flying and consequently blown to sea. Thus by natural selection the beetles with defective wings will be favoured and preserved in the island so as to breed their like and establish wingless races or species. Darwin did not himself apply this parallel to the case of blind animals in caves. But many years ago, in the course of a discussion in one of the reviews, on the probable history of blind animals in caves (and in the deep sea), I ventured to do so. As it seems to have escaped attention in the interval, I submit this suggestion for consideration at the present juncture. Supposing, whether by gradual wandering into caverns (many of which are of vast extent) or swept in by swollen streams or floods, a considerable population of animals become the more or less well-established occupants of caverns. Then there will always be a tendency for those possessing normal eyes to follow up any gleams of light which they may encounter in their exploratory wanderings. They will follow up the light to some passage by which it enters the cavern, and gradually year by year escape in considerable numbers to the sun-lit surface. Those

with defective eyes will not thus escape, but remain and breed in the cave, establishing a series of races or species with defective eyes. The tendency of this process will be to favour the escape of those in every generation with normal eyes or with definite though feeble light-sensibility. These will include many born in the cave from parents with partially defective eyes. Thus constantly, year by year, the cave-dwelling blind forms will become purified from admixture with those possessing eyes of even minimal efficiency as organs of vision. The blind races remaining in the cave will develop in some cases organs of touch of special efficiency, and become established as blind cave-dwelling species.

No doubt further details as to the structure and functional qualities of the eyes of cave-dwelling animals are needed for fuller consideration of this matter, as well as an understanding of the malformations and congenital variations of eyes and of the essential optical mechanisms of eyes of all kinds. It seems to be a legitimate hypothesis that the modification of the organs of vision and their accessory parts in deep-sea fishes and deep-sea crustacea is brought about by photo-taxis migration similar to that affecting cave-dwellers, though at present this is merely a suggestion. The very curious modifications of structure in the eye-stalks of several deep-sea decapod crustaceans which have lost the power of vision have been described and figured by G. O. Sars. I have described and figured such modifications in species of the deep-sea crab, *Cymonomus*, and reproduced for comparison some of the figures given by Sars (see "On the modification of the eye peduncles in crabs of the genus *Cymonomus*," in *Quart. Journal Microsc. Sci.*, vol. 47, p. 439, and Plates 33 and 34). Histological details in regard to the changed and dwindled organs of sight in deep-sea animals have not yet been ascertained, nor is the process of change and degeneration as yet interpreted in relation to known morphological generalisations.

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Choice of the Striking Point in the Pianoforte.

In his interesting letter dealing with the above subject in *NATURE* for October 17, p. 575, Mr. R. N. Ghosh appears to suggest that there is disagreement between S. K. Datta's results and my own. This apparent disagreement is due to a difference in the relative masses of the hammers used. Quantitative experimental results so far published are:

Position of Impact (a/l) giving Maximum Amplitude of Fundamental.	Relative Mass of Hammer (m/M)
$1/4$	$1/2.53$
$1/5.56$	$1/1.18$
$1/6.82$	1.0
$1/7$	1.687 (Datta)
$1/28.6$	9.625

where a = distance of struck point from nearer bridge, l = length of string, m = "mass" of hammer, and M = mass of string. From this table it is clear that as the relative mass of the hammer increases, the position of the impact giving the greatest maximum amplitude of the fundamental moves nearer to the bridge. There are other maxima and minima which become fewer and less pronounced as the relative mass of

the hammer is reduced, until for the mass ratio $m/M = 1/2.53$ there is only one minimum and two maxima for the whole length of the string. The maxima are greater and the minima are less the nearer they are to a bridge. Reference is also made to the work of G. H. Berry, but in this case the mass of the hammer is not given.

The statement that the duration of the impact is about *one-half* the fundamental period of the string when the amplitude of the fundamental is a maximum would appear to be true only for some particular mass ratio. S. K. Datta (*Ind. Ass. Proc.*, vol. 8, p. 116, 1923) finds a duration of nearly *three-quarters* the period of the string for a maximum when $m/M = 1.687$. The treatment of the problem from the point of view of the duration of the impact presents great difficulties, for on the modern general theories this quantity cannot be derived analytically. Moreover, Prof. Raman has theoretically shown the interesting fact that the duration of the impact grows in a *fluctuating* manner as the position of the impact moves from a bridge to the mid-point of the string. This phenomenon has been verified experimentally by his own work and also incidentally by some of mine, where the conditions and method of measurement were quite different.

Influence of Energy Absorbed—The problem may be examined from another point of view. In using an instrument like the violin or the organ, energy is almost continuously given to the system so long as sound is needed, but whatever energy is to be given to a note of the piano has to be communicated in, say, $1/50$ to $1/5000$ sec., depending on the pitch of the note. It therefore seems of interest to examine the influence upon the energy given up to the string by the hammer, of such factors as the position of the impact, the mass and speed of the hammer, the nature of the hammer face, and the stiffness and tension of the string. The experimental work for this investigation is now being carried out at University College, Nottingham, by Mr. H. E. Beckett. We are able by the method in use to make absolute measurements correct to within perhaps 1 per cent of the energy absorbed, and it is hoped to have the work ready for publication by the end of the year.

There are several misprints in Mr. Ghosh's letter. Datta should read Datta; $1/91$ should read $1/7$ in the first place, and $1/9$ elsewhere where l = length of string. Also $1/71$ should read $1/7$.

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The Zeeman Effect on the Helium Bands.

PROF. NICHOLSON has recently (*Phil. Mag.*, vol. 50, p. 650, 1925) pointed out the importance of investigating the effect of a magnetic field on the so-called "doublet bands" of helium. He gives reasons for expecting that these particular bands should be subject to a Zeeman effect of the same general character as in the case of atomic line series. Apart from this, such an investigation would be amply justified by the singularly interesting nature of these bands, both as regards their distribution in the spectrum according to a line-series law and the details of their structure (see Curtis and Long, *Roy. Soc. Proc. A*, vol. 108, p. 513, 1925). It happens that we had already completed the experimental part of such an investigation when Prof. Nicholson's paper appeared, and as the final results will not be ready for publication for some months, it may be of interest to describe their salient features at once.

A large electromagnet and the 7 ft. 9 in. concave grating in the Physics Branch of the Artillery College were very kindly placed at our disposal by Prof. Andrade, and helium tubes of design suitable for end-on observation in a direction perpendicular to the magnetic field were specially prepared at King's College. Fields up to 20,000 gauss were employed, and plates were taken simultaneously in the grating third order and in a Hilger constant deviation spectrograph in conjunction with a Fabry-Perot 1 cm. etalon. Only the strongest band, that near $\lambda 4650$, which is the first member of the Rydberg band-series, has been studied so far, although many other band lines between $\lambda 4380$ and 4720 appear on the plates, and it is hoped to extend the investigation to the second member of the Rydberg series, the band near $\lambda 3680$.

The band-lines exhibit no Zeeman effect of a "normal" order of magnitude except in the case of the first member of each of the three branches constituting the band, namely, $Q(1)$, $R'(1)$ and $P(2)$. These are broadened but not resolved into components, as are the neighbouring He lines $\lambda 4713$, 4471 , and 4388 , even when examined through a polarising prism; this appearance may, of course, be due to a structure more complex than the resolving power available is capable of revealing. It is noteworthy, however, that in $Q(1)$ and in $P(2)$ the component corresponding to vibrations parallel to the field is considerably broader than the "perpendicular" component, whereas the reverse is the case both in the "normal" and "anomalous" Zeeman effects in series lines. In the case of $R'(1)$ the difference is much less marked and is probably opposite in direction; that is, the "perpendicular" component is slightly the broader.

The magnitude of the effect is greatest in $Q(1)$, the extreme width of which in a field of about 20,000 gauss corresponds to a separation (presuming it to be an unresolved doublet) of about $0.27 \text{ \AA.U.}$, that is, roughly two-thirds of the "normal" Zeeman effect, which is shown by the nearest He line $\lambda 4713$ ($0.40 \text{ \AA.U.}$). It is appreciably smaller in $P(2)$ and in $R'(1)$. In each branch the effect diminishes rapidly with increase of order number of the lines, that is, rotational quantum number, but it is still appreciable on the interferometer plates down to the fifth or sixth member of each branch, where it amounts to a few hundredths of an Angstrom only. It is thus clear that the effect of the magnetic field on the molecule is largely determined by the state of rotation of the latter, being relatively small for the higher speeds of rotation.

It may be that these results, if of general validity, will be of use in the analysis of band spectra. Thus, for example, in the helium band spectrum itself there are, in the region covered by our present plates, a number of lines not yet arranged in series, a few of which show pronounced Zeeman effects of the nature described above, and would therefore be expected to be the first members of their branches. Similar considerations may possibly be helpful in the analysis of the secondary spectrum of hydrogen. Evidently it cannot be assumed that a line showing an appreciable Zeeman effect must belong to a line-series rather than to a band-series, or that an affected line is *ipso facto* disqualified from association with unaffected lines. In this connexion it would appear desirable that the Zeeman effect on the latter spectrum should be investigated over a much wider range of wave-lengths than was attempted by Dufour (*Jour de Phys.*, 8, p. 258, 1909).

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Birth-Control among the New Zealand Maori.

IN NATURE of October 17, p. 575, Miss Ettie A. Rout has made some interesting remarks concerning sexual life and birth-control among the Maori of New Zealand. Anthropologists and students of social hygiene will be grateful to her for directing attention to facts which have previously received little notice—the value attached by the native to physical fitness, its importance as one of the criteria of marriage, and the consequent influence of this ideal upon the general physique of the race. At the same time, it should be recognised that such important social institutions as betrothal, marriage and family life were not regulated by physical fitness alone, as Miss Rout seems to imply. Despite my sympathy with her views, I cannot help wondering whether these have not unconsciously coloured her statements about Maori life.

We are told, for example, "before betrothal occurred there was medical examination of both parties by the parents of the young couple and by the doctors." That this was a pre-European practice is very much open to doubt. In any event, from reasons of personal friendship of the parents, or tribal policy, betrothal quite often took place in early childhood, even soon after birth. Preliminary "medical examination" at such a stage, however, would scarcely appear to possess any great virtue in establishing fitness for reproduction. Also, if Miss Rout's statement is to be taken as valid, it must occasionally have been a matter of some delicacy, inasmuch as we know that infants were sometimes *taumau* (betrothed) before birth with the expectation that they would later turn out to be of different sexes!

Now as to "doctors." To elevate the old-time *tohunga* (priestly expert)—who is apparently the person meant—to the style and dignity of a *doctor* is, quite unintentionally no doubt, to give to European readers a highly exaggerated notion of the medical knowledge and capabilities of these folk, who were far more learned in magical practices than in physiology or pathology.

Before marriage a great amount of sexual freedom was allowed to the young people among the Maori, but after marriage was concluded strict fidelity was demanded. In general, the marriage bond was highly respected. Liaisons, of course, occurred, but adultery was never condoned; on its discovery a *taua miru* or plundering party which stripped the offender of property, was the result, while for an erring wife death was by no means a rare punishment. With these indisputable facts at disposal, it is difficult to see why Miss Rout has come to the conclusion that a married woman was allowed to have her children "by whatever father she desired." Again, it is stated that a woman "if she preferred some other man to become the father of her child might allege that this lover's spirit visited her" and that this was "a recognised polite fiction." It is to be feared that a Maori of the old school would indeed label it a fiction, though not of a very polite order. Moreover, to the children of any illicit unions a great stigma attached—the term *pororo* (bastard) was a perpetual shame to the person concerned; such an illegitimate child might be killed by the woman's husband or father, and women resorted to abortion rather than give birth to such. It is somewhat difficult, then, to conjure up Miss Rout's picture of a Maori warrior, humbly acquiescent in his wife's intercourse with another man, his sole reaction being one of self-pity because she considered her paramour a better potential father for her offspring.

In her selection of a husband, the Maori woman was drawn by his handsome appearance, his excellence in the *haka* (posture dance), his powers in war, his skill as a food provider, rather than by exalted notions

as to his worthiness for the high office of producing children by her. In brief, marriage and family relations among the Maori were determined by many other social factors besides that of physical fitness.

In substantiation of my remarks I refer the reader to various papers by Best, Gudgeon and Dr. Goldie in the Transactions of the New Zealand Institute and Polynesian Journal, besides the writings of S Percy Smith, Judge Wilson and James Cowan, whose statements are fully confirmed by my personal knowledge of the natives in the Waikato and the Urewera districts.

RAYMOND FIRTH.

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(University of London).

Greenland or Polar Front?

No doubt the gravitational outflow of air from the ice-dome of Greenland is the source of a good deal of cold air to the cyclones of the North Atlantic, as upheld by Prof. Hobbs in his paper to the Geography Section of the British Association at Southampton, and printed in NATURE for October 3. But why, many meteorologists will ask, should he go to the extreme length, implied in the article, of disregarding other sources of cold air for the Bjerknesian mechanism of cyclonic circulation? Can Prof. Hobbs seriously intend that the sloping ice plateau of Greenland, so very limited by comparison in area, can supply all, or nearly all, the cold air for the cyclonic activity of the entire northern hemisphere, Pacific, as well as Atlantic, centre? The idea seems incompatible with the scale of operations, and the facts quoted by Prof. Hobbs himself, if rightly interpreted, show that it really is incompatible. Of course, if Greenland were denuded down to sea-level one spring in the mechanism would be removed, and doubtless important modifications would be imposed upon the characteristic circulation of the North Atlantic Ocean, for in the last resort the details of the atmospheric circulation and the perpetual transpositions of the Polar Front are dominated by geographical configuration, or in other words by continentality and oceanity relationships. But the facts do not warrant the contention that Greenland, in a sense an accidental feature in the circumpolar configuration, is the mainspring of the circulation in the northern hemisphere.

Take the very fact adduced by Prof. Hobbs of the mean barometric pressure over the north polar basin, as established by the late Prof. Mohn, not being inordinately high. This is of little consequence. What is of consequence is the fact that the mean polar pressure is higher than the Atlantic minimum near Iceland and the Pacific minimum in the Bering Sea. This mean or average distribution of pressure means, when translated into *day to day changes*, that just as warm, humid equatorial air commonly drifts northward, so will cold dry polar air frequently drain southward irrespective whether Greenland is there to reinforce the process or not. This statement is simply in accord with the known laws of wind and pressure distribution, and every modern weather forecaster is familiar with true polar air on his day-to-day charts.

Then we are told that the air of the polar basin "where rain and fog are common" is not of the right quality to form discontinuities and interact with the equatorial currents in accordance with the admitted Bjerknesian process. Yet what could be farther from the truth than this statement? The north polar basin or Arctic Ocean is in the winter months one of the three "poles of cold" in the northern hemisphere, with a

mean January temperature round the Pole, according to Mohn, of -40° F. or C., the other two being north-east Siberia and the Greenland ice-dome itself. This extremity of cold over the inner polar basin necessarily implies dry air, and all polar explorers have testified to the *sparkling dry* atmosphere of the long polar night. The rain and fog occur temporarily and locally in the thaw weather of summer (never in winter except occasionally near Spitsbergen where there is warm Atlantic water); but, even so, outflows of polar air are amply cold and dry enough to interact with the equatorial air to supply the milder cyclonic activity of summer.

It must not be forgotten, further, that in winter the frost-bound continents can constitute additional reservoirs of "polar" air; and this fact is one of the chief, if not the chief, cause of the terrific state of turmoil which the North Atlantic Ocean is commonly in during the months of December and January—when supplies of "polar" air, to interact with warm damp Atlantic equatorial air, may be drawn not only from the North Pole and Greenland, but also from North America and Europe.

Finally, it should be observed that "glacial anti-cyclones" of the Greenland or Antarctica type are really disembodied systems, and it would surely be better to speak of gravitational cataracts of cold air. But that is another story. L. C. W. BONACINA.

27 Tanza Road, Hampstead, N.W.3,
November 4.

Relation of Language to Physiological Stimuli.

In examining a vocabulary of more than a thousand words (compiled from upwards of sixty languages) bearing directly or indirectly on the sense of smell, it becomes apparent how many words are vocalisations and articulations of simple reactions to olfactory stimuli. A few examples must suffice here. [ch = ch in *loch*, ch = tch.]

A common reaction to odours would be the syllables like *bu*, *pu*, *fu*, *hu*, *su*, *tu*, etc., expressing the idea of blowing, puffing, budding, bulging, etc., and we have, e.g. Persian *bu*, odour; Efik *bu*, to rot, and *bu-bere*, to blaze; Circassian *buà gim*, sense of smell; Efate *busi*, to blow; Malay *busuk*, putrid; Chinook *pu-piu*, to stink, also skunk; Tibetan *po*, incense; Tahiti *puha* and Hawaiian *puki*, to blow; Samoan *puaoa*, mist; Inca (Quichua) *puhuni*, to blow, *puhucuni*, to kindle, *hapuni*, to smoulder, *puhura*, feather, and *puyuu*, cloud; Melanesian *punu*, smoke; Japanese *punpun*, like a delicious perfume, Samoan *punapuna*, to ascend; Russian *puvchnut*, to puff, blaze, and *puch*, feather. We have the international expressions of disgust, e.g. *faugh*, *pfui*, *fi*, etc. We have *simus*, *fumus*, *foetid*, and so forth, the Efik word *fula*, to blow, Chinese *fu*, fragrance; Japanese *fuki*, to blow (*hanafuki* = handkerchief), and *shuki*, stench; Natick Indian *shuah*, to stink; Basque *su*, fire and nose; Latin *tus* and Gaelic *tus*, incense; Russian *tuman*, fog, Melanesian *tunga*, fire, Zulu *tunga*, smoke (cf. *dung*, *Dunger*, *tongue*, etc.); Basque *tusuri* and Tibetan *du*, devil; Ancient Egyptian *chua*, to rot; Chinese *cheu*, stink, and smoke; and Russian *chuyanne*, scenting, understanding. Of interest here, too, are the Tibetan *u*, breath, and Honorific Tibetan = head, Russian *um*, mind = reason; the Inca *uma*, head, and *umu*, priest, the German *Atem*, *Odem*, breath; *Odin*, and the sacred *OM*, Ancient Egyptian *utu*, flowers, unguent; Basque *usu*, pus; Micmac *un*, fog, etc.

Another natural vocal reaction to olfactory stimuli, and of course connected with breathing, is a combination of guttural and vowel sounds and words, perhaps sometimes vocalisation of hawking or vomiting. To

quote but a few examples we have the Danakil *haha*, air; Seneca *gahah*, wind, and *gaoh*, air (cf. *gas*); Tibetan *gak-pa*, to be choked, Inca *chahani*, to kindle; Persian *gand*, stink; Urdu *gandhak*, sulphur; Japanese *hana*, nose, flower, the first; the Ancient Egyptian *cha*, to enter, and *chen*, flowers; *Ka*, the eidolon or familiar; Gipsy *cannelo*, stinking, and *noh*, nose, Melanesian *guoko* and Eskimo *kenowk*, nose, Circassian *chassa*, to learn; Arabic *chassal*, sense of smell, Inca *chosni*, smoke, and *kumpi*, sweat, Chinook *hummi*, stunk (Ar. *shamm*, to smell, Russian, *shaman*, sorcerer; etc.); Inca, *chuncu*, stink; Yao *nunga*, smell; Suahili and Zulu *nuka*, Congo *nukana*, and Chinyanja *nunktsa*, to smell; Russian *nyuchal*, to smell (cf. *nauk*, science)

The significance of the combination of the nasal and guttural sounds in connexion with smell may be seen by means of the following, somewhat rough, expedient. Taking 100 words signifying *nose* from Asia, Europe, Africa, Australia, the South Sea Islands, and America, and analysing the sounds present, it was found that of the 235 consonants present, 102 were n, ng, h, k, ch, and q; 59 were s, z, sh, zh, j, tch, d, and t, 35 r and l, 20 b, p, f, v; and 19 m. Of the 224 vowel sounds represented 63 were u, w; 53 a, 47 i, y, 36 o, o, and 25 e, a. While this method does not commend itself to philologists, it may serve to indicate a new way of building up an international language, based on the physiological reactions to stimuli, and in any case affording food for thought and discussion. It must be borne in mind that the few examples quoted above do not necessarily indicate their ontogeny. Perhaps what has been said about the nose may suggest even a connexion with the Ankh, and may not the anchor perhaps suggest a nasal symbolism?

JOHN H. KENNETH.

The Homestead, Clynder,
October 14.

Could the Romans in Britain weld Iron?

INCREASING attention has, within the last few years, been devoted to Roman remains in Britain, and a great deal of interest centres round such metallic remains as have survived from this period. Iron was always manufactured by the so-called "direct" process, that is, iron ore was reduced with charcoal direct to the metal without the intermediate formation of pig iron. The method was very wasteful, and in the further working of the metal so much oxidation took place that frequently the whole of the metal disappeared, the finished article consisting almost entirely of the hard ferrosferic oxide, the remainder being slag or other impurity. This was the case with certain "iron" nails from the Roman villa at Folkestone which were forwarded to me by Mr S. E. Winbolt.

As the Roman method of heat treatment was so crude and resulted in so much oxidation, I have often wondered if it was possible for them to weld their iron. Through the kindness of Mr. Walter G. Klein, I have been able to examine specimens of Roman iron from the excavations at Richborough, and an account of these was laid before the autumn meeting of the Iron and Steel Institute by Mr. W. E. Thorneycroft and myself. One piece of iron, when sawn through, showed that it consisted of a bundle of about 8 rods which had apparently been hammered together to make them unite. But metal did not touch metal, for each rod was separated by a thick layer of impurity, containing 45.47 per cent. of iron and 24.54 per cent of insoluble material, mainly silica. The rods held together with surprising ten-

acity, but a heavy blow cracked the cementing material, when they readily fell apart.

An iron ring was examined from the same source, and we thought that this might indicate whether or not the Romans could weld. At first we thought we had a clue. There was a distinct crack visible under quite low magnification at one part of the ring. But on further grinding this disappeared and no further evidence of a weld was obtained. The ring might therefore have been made by driving a hole through a plate, for its external diameter was only 40 cm., the mean diameter of the metal being 0.75 cm.

A week or two ago I received from Mr Francis B. Andrews, secretary of the Birmingham Archaeological Society, a piece of Roman iron pipe from Uriconium. It was a ring of metal, not unlike a serviette ring, 4.3 cm in diameter and 1.5 cm deep. On grinding down it became evident that the ring had been made by bending over upon itself a piece of sheet iron and cementing or "soldering" the join with molten copper or copper alloy.

There has not yet been time to examine the specimen micrographically, or to determine the particular composition of the cupriferous "solder". A full description of these will, it is hoped, appear in due course.

Searching through the literature, I have been unable to find any reference to this kind of thing before, and it would be most interesting if any of the readers of NATURE could cite further examples.

One of the great difficulties of work of this kind lies in the fact that the antiquary naturally desires to preserve his "finds" and hesitates to allow objects of interest to be examined by any chemical or metallurgical process that may tend to destroy them. With this we all sympathise. Yet where specimens are not unique, but fairly common, it might be possible to hand some of these over to tried investigators in order that science might benefit by a further examination, even at the risk of spoiling for exhibition purposes these duplicated specimens.

My sincerest thanks are due to those gentlemen who have so generously placed at my disposal the material discussed in this note.

NEWTON FRIEND.

Municipal Technical School,
Suffolk Street, Birmingham,
October 27.

Weather Prediction from Observations of Cloudlets.

I do not think that the method described by Sir G. Archdall Reid in NATURE of November 7, p. 676, is at all of universal application. It certainly cannot be applied to cirro-cumulus; the cloudlets composing lenticular cirro-cumulus not only *may* wax at one end of the cloud and wane at the other, as mentioned by Sir G. Archdall Reid, but they always behave in this way. I do not think that any of the explanations he gives accounts for the phenomenon, but the point is not to account for it, but to decide whether the waxing or the waning of the cloudlets is to be taken account of in weather prediction. Again, a whole mass of cirro-cumulus cloudlets may form and disappear in a very short time, is the appearance or the disappearance to be reckoned with? The lower clouds seem to me to tell even more against the method, on almost every fine summer morning we may watch cloudlets waxing, but it by no means follows that rain will result, probably in nine cases out of ten it will not. I should imagine that there must be nearly a hundred days every year when the method is disproved by the waxing of cloudlets which will develop not into rain clouds, but into the cumulus of a fine day.

C. J. P. CAVE.

Stoner Hill, Petersfield, November 9.

Michel-Eugène Chevreul, 1786-1889.¹

By Prof. HENRY E. ARMSTRONG, F.R.S.

RECENTLY, in London, we celebrated the centenary of the discovery of benzene by Faraday and in so doing took occasion to proclaim Faraday's greatness as a chemist. The commemoration was remarkable, because it was held by the Royal Institution, where the discovery was made, in conjunction with three other associations: the Chemical Society, the Society of Chemical Industry and the Association of British Chemical Manufacturers. This was the first time these three bodies, which collectively represent all the interests of British chemistry, have shown themselves to be actuated by one purpose and have elected to work to a specific end, in harmonious, declared co-operation. In England, we regard the event as a happy presage of the union we have long sought to achieve—the union of our chemists into a single professional organisation.

Now, a further step is taken along the same path. I am charged by the Royal Society of London and the three bodies I have mentioned, which again act as one, with the honourable and most gratifying task of conveying to our French colleagues, their united warmest congratulations upon this occasion. We not only desire to join in paying homage to Chevreul's memory: we also desire both to carry on the work we began, with the powerful aid of French men of science, in London and to aid them in reminding their public of the inestimable value of genius and in enforcing upon the attention of the rising generation of students the value of the examples before them in the work of the famous men of the past.

The world of to-day is accustomed to take advantage of the work its leaders do for it, without in the least attempting to understand what leadership is and entails. Our need of leadership, the paucity of leaders, was never more obvious, perhaps never so great. We are too prone to think in terms of majorities—forgetting that evil may often, more easily than good, command a majority. We do not sufficiently realise how much the War has cost the nations in leadership. On such occasions as this, we do well to pose such problems before the public.

We have a remarkable series of English essays, too little read to-day, I fear, on "Hero-Worship," delivered by our great man of letters, Thomas Carlyle, the historian of the French Revolution. His heroes were: Odm and Mahomet; Dante and Shakespeare; Luther and Knox; Johnson, Rousseau and Burns; Cromwell and Napoleon: representing divinity, poet, priest, letters and king. Science was not considered: letters have yet to fathom its mystery, if indeed it be fathomable by the literary mind. Even Anatole France, though respectful, is fearful of us; he even goes so far as to say: "Our chemists and our professors of science are almost to a man anarchists." He probably failed to recognise, that the religion of the future, if indeed there be one, will be fashioned out of pure knowledge. Being, we are told, "liberated from religious belief, lacking the organ of superstition," he

was perhaps unable to realise that the true office of science is to create belief by destroying dogma: to govern by necessary commandments.

Meetings on such occasions as this serve to correct unjustified literary partiality and misreading of our character. We can rejoice in what Chevreul did for civilisation, not against it: he was a veritable torch-bearer: he not only made the torch a thing of beauty to the eye but also deprived it of all offence to the nose. In doing so, he liberated glycerol but it remained for Sobrero to convert this into an engine of war.

Were Carlyle writing to-day, he would perforce include science in his gallery of heroes. The choice of representatives would be difficult. Certainly, one of the first to consider would be Lavoisier, the greatest philosophic chemist of all time. Then would come Faraday, I think, especially on the grounds of his moral outlook. To France would fall another nomination, that of Pasteur, as a great humanitarian. Anatole France would never have classed us as ultimately dangerous had he studied such examples. It would have interested him to know that, in 1824, the celebrated home of Sir Walter Scott, at Abbotsford, was lit by oil-gas, made from material which his countryman Chevreul was the first to study, the "gas" from which Faraday, a year later, was to isolate benzene. Not to be outdone by the Church, at the recent celebration, in London, of Faraday's discovery, in the evening, at the banquet in the Hall of the Goldsmiths' Company, one of the private palaces of our City of London, no less a number was lit than 578 of the candles made possible by Chevreul's invention of 1825. In such manner was honour done to the coming of benzene, in such manner was the chemist's "open chain" connected with the "closed." The great hall in which we met is one of the few now illuminated in accordance with ancient custom—by burning oil-gas, *in situ*, as it is produced from Chevreul's candle with the aid of the "retort" patented by Cambacères in 1834. To-day, Chevreul and Faraday march arm in arm, illuminating the world—the one bearing the candle, the other the electric torch. Anatole France, doubtless, in his time, burnt many candles as midnight oil—how then could he call us anarchists, unless it were because of the support our work gave to his anticlericalism? Had it not been for the constitutional inability of the literary to understand the experimental mind, he must surely have treated us as the most lovable of brethren.

Working as chemists, Chevreul and Faraday between them, practically at the same time, laid the foundations of organic chemistry: Chevreul of its open or paraffinoid, Faraday of its closed or phenoid systems. In our inability to escape from ancient practice, motorists to-day, fire-worshippers as they are, finding it to their advantage to associate the two types of combustible, unconsciously, the world over, render their burnt offering to the memory of the scientific fathers that begat them.

Chevreul's has long been an honoured name in England. He was elected a foreign member of the Royal Society in 1826 and received the Copley Medal,

¹ Address delivered at the fifth Congress of Industrial Chemistry organised by the French Society of Chemical Industry, on October 11, at the centenary celebrations of Chevreul's work on fats.

its highest honour, in 1857. He was elected a foreign fellow of the Chemical Society in 1849.

In the obituary notice published by the Royal Society (1889), it was said :

He will be known for his researches on the contrast of colours but his great work was that by which he cleared up the constitution of the fixed oils and fats and established the theory of saponification. Few scientific men surviving were even born^a when this important research was commenced—a research in the course of which he laid the foundation of the method now universally followed in the study of organic compounds, by showing that an ultimate analysis by itself alone is quite insufficient and that it is necessary to study the substances obtained by the action of reagents on that primarily presented for investigation.

The notice given in the *Journal of the Chemical Society* (1890) is in similar terms. His investigations are said "to cover the whole of chemistry, branching out into physiological chemistry, hygiene and physics." In our survey we are carried far back, in the history of the development of the method of chemical inquiry, in considering Chevreul's early contributions. I have difficulty too in picturing his masterful activity—it was so ceaseless and varied. He thoroughly deserved the title he was accorded of "Encyclopédie vivante." To-day, students know him only as a chemist who lived to be more than a century old and was the discoverer of the higher fatty acids. Few will have seen the wonderful bibliography prepared, at the time of his centenary, by M. Godefroy Malloizel. The items catalogued number 506, including several comprehensive treatises. In our English Royal Society's *Catalogue of Scientific Papers*, 233 titles appear under his name, between the dates 1806 and 1884.

Born at Angers in 1786 and educated there, at the *École Centrale*, in 1803, at the age of seventeen, he went to Paris and was admitted by Vauquelin, the discoverer, in 1797, of the element chromium, to his chemical manufactory but soon became chief of the laboratory. In 1810, Vauquelin appointed him his assistant in his course of applied chemistry at the Museum of Natural History. In 1813 he obtained the chair of chemistry at the *Lycée Charlemagne*. In 1824 he became professor of special chemistry at the Gobelins tapestry factory and succeeded Roart as director of the dye works.

Chevreul began to publish in 1806. His early work was of a miscellaneous character. He began to study indigo in 1807 and was the first to recognise that it occurred naturally in "its lowest stage of oxidation" as indigo white. In 1811, he isolated the yellow colouring matter quercitrin. Morin and luteolin were discovered by him in later years. In 1815 he proved that diabetical sugar was identical with starch (grape) sugar. He began his studies of the saponification process in 1810 and recorded the results of his examination of the fats, in a series of papers, between 1813 and 1818. He discovered butyric, valerianic and caproic acids in 1818 and oleic acid in 1823. In 1832 he prepared kreatin from meat extract. He studied wool-fats in 1853. His attempt, in conjunction with Braconnot and Gay Lussac, to establish the stearin candle

industry receives notice at other hands. It is well known that the manufacture was not successful until after the introduction of Milly's improved process of saponifying with lime and the invention of the plated wick by Cambacères in 1834. In its early stages, the industry was largely developed in England by Price and Co. It has now reached colossal dimensions, though the hydrocarbon paraffin has largely taken the place of stearic acid.

Like Faraday, Chevreul was no mere laboratory worker: he was not only a philosopher but also a systematist and logician of the first order. His scientific writings are all models of clear and simple statement and a complete justification of the motto he adopted, from Malebranche, as his guiding principle, "On doit tendre avec effort à l'infailibilité sans y prétendre."

Recognising "les inconvénients d'exposer de nombreuses recherches sur un même sujet dans une suite de mémoires," in 1823, he published, in book form, a comprehensive account of his work on the fats—"Recherches chimiques sur les corps gras d'origine animale," which he dedicated to Vauquelin.

The point of view from which his work generally had been undertaken is clearly defined in the introduction to this volume, in the following terms :

On dit que la chimie se compose de faits, mais des faits seuls ne constituent pas cette science, car lorsqu'on donne des définitions générales, lorsqu'on forme des groupes de corps d'après des propriétés analogues et des propriétés différentes, il a fallu nécessairement interpréter des faits déjà observés pour établir les rapports qui les lient. Lorsqu'on définit, il y a donc des rapports établis et on reconnaît des propriétés de différent ordres, quant à l'importance qu'on attribue à chacune d'elles : dès lors il y a plus que des faits, quoique en dernier ressort toute interprétation, toute définition, doivent s'appuyer sur des faits bien observés. Priestley a découvert un grand nombre de corps importants, il a reconnu la plupart de leurs propriétés et certainement il a fourni à la science plus de faits proprement dits que Lavoisier, cependant, sans que nous ayons l'intention de diminuer en rien la gloire du savant anglais, nous pouvons dire, sans crainte d'être démenti, que la postérité a placé Lavoisier au-dessus de lui. Quelle en est la cause, si ce n'est pas la manière dont les faits ont été interprétés ? Ce qui est vrai pour les faits qui ont servi de base à la théorie antiphlogistique, doit l'être pour ceux qui restent à découvrir : nous pensons donc qu'au lieu de recueillir sur des sujets très différents des faits qui manquent de corrélation, il est préférable pour le progrès de la science de rassembler le plus possible des faits analogues, de les coordonner ensemble, afin d'en déduire les conséquences générales, qui seules peuvent imprimer à un ensemble de faits le caractère constitutif de la science.

Lorsque nous avons commencé l'étude des sciences physiques, nous avons été frappés du vague qui régnait alors dans la chimie organique, en même temps que nous avons aperçu l'étendue des applications qu'on peut faire de cette branche de la philosophie naturelle aux sciences physiologiques et anatomiques, à la médecine et à ces arts nombreux dont l'objet est de préparer avec la matière des corps organisés des substances utiles à l'homme. Tels sont les motifs qui nous ont engagés depuis longtemps à réfléchir sur tout ce qui se rattache aux connaissances chimiques des produits de l'organisation.

^a Chevreul was only eight years old when Lavoisier was executed.

Nous nous sommes appliqués à connaître les principes que l'on sépare immédiatement des végétaux et des animaux, parce que cette connaissance est la base de la chimie organique et de toutes ses applications.

In a second volume, published in 1824, "Considérations générales sur l'analyse organique immédiate et sur ses applications," Chevreul dealt more generally with the methods to be followed in examining natural products. The copy of this book that I have consulted came from Faraday's library; that dealing with the fats was a presentation copy to Mitscherlich. He not only discussed the use of solvents but also the mode of action of the various chemical agents. The following quotation will serve to illustrate the crude state of knowledge at the time: "M. Berzelius a dit que la fibrine du sang, l'albumine, la gélatine, éprouve sur l'influence de l'alcool et de l'éther une altération telle qu'une partie de leur matière est transformée en substance grasse adipocire."

After describing his experiments to test this statement, Chevreul concludes: "J'ai été ainsi conduit à reconnaître que les substances grasses contenues dans l'alcool et dans l'éther qui ont été mis en contact avec des tendons, etc., sont simplement extraites de ces substances et non produites aux dépens de leur éléments."

What Chevreul would have attempted, what he would have achieved, had he remained a chemist and a free lance, it is difficult to say. I venture to think that systematic inquiry in organic chemistry might have been made more *de règle* at a far earlier date than it was. The fates determined that he should be called off to deal with the problems of colour and of practice. No one has handled them more comprehensively, more logically, than he did, in his capacity of Director of Les Gobelins. Not satisfied with treating the subject as a chemist, he at once proceeded to inquire into the effect of contrast in colour—not only in tapestry fabrics but also in clothing, in house decoration and even gardening—including the planting of the dahlia, the now-fashionable flower. His great work "La Loi du contraste simultané des couleurs," first published in 1839, was long out of print. A new large quarto edition, with a preface by his son, was issued by l'Imprimerie Nationale in 1889. That he retained his interest in colour to the last is proved by his communication to the Institute, in 1884, in his ninety-eighth year, entitled "La Vision dans ses rapports avec les contrastes des couleurs."

Chevreul ranks alone as a student of the philosophy of the dyer's art apart from his craft. His works deserve renewed attention, at a time when colour plays so important a part in our civilisation. Judging from what I have seen at the Exposition Internationale des Arts Décoratifs, modern artists might consult them with advantage.³ The first to study indigo, the dyestuff

³ In Paris, we had many opportunities of appreciating the importance of Chevreul's efforts to direct the use of colour and of noting how great is the part to-day played by its glory. The public gardens, those of the Luxembourg especially, were ablaze with it, the Dahlia being the predominant factor in its production. At the Exhibition of Decorative Arts it was everywhere to the fore. Many most exquisite effects and contrasts were to be seen in jewellery. Striking beyond measure, however, was the wondrous exhibit of the Lyons silk manufacturers. The colour contrasts and patterns were not always such as Chevreul would have advised but marvellously effective, for the most part. To judge from the display at the Salon, in comparison with that at the Exhibition, painters are no longer mindful of the rainbow, seeking to attract rather by abrogating than by following the harmonies therein disclosed. The potters, too, are behind in evolving pleasing effects and the glass makers also seem to be lacking in

which still ranks before all others in importance, no one would have been better able to appreciate the extraordinary advance, within recent years, in our knowledge of colouring matters, both scientific and practical: he would have specially welcomed the discovery of the superlatively resistant indigo-like dyestuffs derived from anthracene and their appearance, in commerce, in the "lowest stage of oxidation," ready for application to the fibre by the dyer.

Some day, we may well compel the admiration of such achievement by the literary mind, even by the poet, if we can but paint the marvellous story in sufficiently simple terms and make clear what it is that has fired the heart of the chemist to match himself against Nature—even to her undoing. Chevreul was certainly one of the earliest and boldest among the conspirators and were he with us, to-day, would undoubtedly have sought to impress upon the public mind the marvellous development our art has undergone since he became its votary—within a single century.

Chevreul was greatly devoted to historical and philosophical study and deeply interested in making known the principles of scientific inquiry. In his "Histoire des connaissances chimiques," published in 1866, he speaks of his long friendship with Ampère and Frédéric Cuvier, begun forty-five years previously and refers to their frequent discussions on the classification of human knowledge. This work is full of sage reflexions. Let me quote one:

L'erreur prise pour vérité a encore le grave inconvénient de mettre obstacle au progrès de la science, parce que si une découverte véritable annoncée est contraire à cette erreur, il arrivera que les partisans de celle-ci repousseront la découverte, c'est-à-dire la vérité plus ou moins longtemps.

Telle est la raison sur laquelle je m'appuie pour réduire l'enseignement élémentaire et l'enseignement dit professionnel à ce qui est vrai et susceptible d'être facilement démontré tel. Car beaucoup de gens qui se disent partisans du progrès, ne voient pas que des erreurs promulguées par ces enseignements comme des vérités, sont autant de semences qui, en se développant dans de jeunes intelligences ou des intelligences d'adultes que nulle étude n'a préparés à les juger, deviennent des opinions erronées qui seront un jour les plus grands obstacles à la propagation de la vérité, c'est-à-dire à ce même progrès que l'on veut favoriser.

L'importance que j'attache à la destruction de l'erreur explique mon ardeur à propager la méthode.

We may well take such admonition to heart, in these days of unchecked hypothesis. If "l'enseignement

true feeling. In fact, the appreciation of colour seems now to have passed mainly into the charge of the textile workers, who not only have an endless gamut of tones at their disposal but are also able to produce varied effects of surface texture, unknown in Chevreul's day, which greatly enhance their power to please.

A happy accident gave us also an opportunity of appraising the value of pure natural colour. Lunching at Foyot's, we were opposite a lady wearing a most becoming "hat" of expensively simple design, a neutral light-brown in colour, who was sitting with her back turned to a window through which the brilliant rays of a midday sun came streaming in, these were evidently caught by a prismatic wedge, for ever now and then, as she moved forwards and backwards, a complete spectrum hung upon her brow and the curved edge of the bonnet—the decorative effect was exquisite, one producible by no conscious art.

A greater opportunity was to come. In the interval, in sunshine and shower, we have explored our English Lakeland region and seen the full glory of the bow resting upon the brows of the fells and upon wondrously sculptured slopes clothed with harmonies of wetted autumnal colour—colour of indescribable, inconceivable beauty, yet mostly traceable to Faraday's benzene and to contrasts beyond compare in which Chevreul especially would have gloried.

dit professionnel" were reduced "à ce qui est vrai et susceptible d'être facilement démontré tel," how much higher would be the task of the teacher and how much more competent the pupil as student and worker.

That philosophical subjects continued to fill his mind is clear from his communication to the Institute, in 1883 (*C. R.* 96, 1521): "Considérations générales sur les méthodes scientifiques et applications à la méthode *a posteriori* de Newton et à la méthode *a priori* de Leibnitz," in which he discussed the diametrically opposite methods of the two philosophers. It would be to the advantage of students, if a complete edition of Chevreul's works could be published at a cheap price. They would be of great value, if only as examples of style.

Like Faraday, Chevreul turned his attention to occult phenomena and dealt specially with certain aspects of occultism, as member of a Commission of three appointed by the Academy, in 1853, to examine a memoir by M. Riondet "sur la baguette divinatoire employée à la recherche des eaux souterraines"; also a letter, by M. Koepelin, "sur les tables tournantes." His report was published in book form under the title "De la baguette divinatoire, du pendule dit explorateur et des tables tournantes." I have had at my disposal the autograph copy of this book presented by Chevreul to the Royal Society of London. He was prepared to undertake the task, having twenty years before addressed a letter to his friend Ampère "Sur une classe particulière de mouvements musculaires," discussing experiments which he had made in 1812 to test the statement: "Qu'un pendule formé d'un corps lourd et d'un fil flexible oscille lorsqu'on le tient à la main au-dessus de certains corps, quoique le bras soit immobile." Like all who have discussed such subjects critically and exactly, he came to the conclusion that the manifestations were to be referred to no "faculté surnaturelle," but to "unconscious cerebration."

Chevreul's work on the fats was limited to the recognition of their proximate constituents. A long series of workers has since laid bare their molecular structure: of these Dumas and Boullay, Gerhardt, Würtz and Berthelot, not forgetting Schorlemmer, were among the first. The story is the story of the development of structural chemistry—a colossal work of the human intellect which is too little appreciated, even in scientific circles.

It is noteworthy that, at this early date, he discussed the possibility of preparing organic substances by artificial means and definitely decided that it is likely that they would be so produced. Four years later, Wohler was to make urea, thus breaking down for ever the barrier between Nature and our art. To-day the Badische Co. is counting upon a production of 20,000 tons per annum and urea may well become the sole artificial nitrogenous fertiliser used by agriculturists. Indigo, Chevreul's early love, is fast being displaced by synthetic indigotin, the world production of which is already rated at 9000 tons (dry weight) per annum. The other natural dye-stuffs he studied are all but unused—the fats alone still carry the bloom of their natural origin, though, taught by Sabatier, we are now accustomed to pale the fresh complexion of those that are oils with hydrogen.

Our art has thus gone far in copying Nature but she

still defies us to read and understand her purpose. We have also done much to alleviate man's ailments and are vastly more powerful. Nevertheless we are no happier nor better attuned to her beauty and goodness. Our art is not yet true art. Would Chevreul have been satisfied with our slavish worship of mere measurement, great as was his devotion to accuracy? Would he not have deprecated our insatiate desire to manufacture everything—our attempts to waive aside Nature's activity in every possible way? Would he not have asked for a less academic and broader treatment—for a greater display of humanity, for more reverence for the great scheme we presume to dissect? No one was more alive to the frailty of the human spirit but no one more conscious of its powers when rationally used. True science is dangerously far from the public ken and we need to recognise the duty that is upon us to bring home to all the infinite possibilities it affords of a future worship of abstract truth.

Chevreul, to-day, would be astounded at the lengths to which we have been carried by application of the philosophical methods of study of which he was so stalwart an advocate throughout his life. We know the structure of the diamond, thanks to the confirmation X-rays have afforded of the chemist's conception of the carbon atom, built upon the foundations laid by Frankland and Kekulé, by Biot, Pasteur, Le Bel and van't Hoff and established by the labours of a vast army of patient students of organic structure. We can, in fact, assert, that the diamond is made up of individual units—carbon atoms—commanding tetrahedral domains. The contiguous units are arranged alternately, as tetrahedra may be, base downwards and base upwards, lines between their centres forming a zigzag and meeting at an angle of 109° , the tetrahedral angle. Recent measurements, made by Dr. Muller, at the Royal Institution, of exceptionally good crystals of stearic acid, show that the carbon atoms in this compound meet at this same angle. In fact, the saturated fatty acids are simple rods of carbon atoms, clothed with hydrogen atoms along their length, their acidity being determined by the presence of a terminal group in which Lavoisier's oxygen is substituted for hydrogen.

This is a strange structure in comparison with that of Faraday's benzene, which may also be pictured as being hewn straight out of the diamond but as consisting of compact hexagonal blocks of six carbon atoms.

Why Nature, in making the fats, should build such extraordinary scaffold-pole like molecules is passing strange. The field is full of problems: it is surprising that so little attention has been given to it (see E. Frankland Armstrong, Presidential Address, Society of Chemical Industry, Liverpool, 1924). I have here a solid model of the geometrical structure of the fatty acids which I owe to Mr. William Barlow, F.R.S. It is a veritable *bougie stéarique*, built, not wastefully, in cylindrical form but so that the individual units interlock to fill space. Mr. Barlow and I believe this model to be worthy of special attention, as it has features which serve to represent peculiarities hitherto unexplained in the chemical behaviour of the fats and paraffinoid compounds generally. If the hydrogen atoms were arranged around the carbon atoms tetrahedrally, they would serve to isolate them in space and the formation of crystalline masses from such units

would seem to be "impossible"; moreover, such compounds would be chemically neutral, assuming hydrogen to lose all affinity when it unites with carbon. In the model before you, as in that of benzene, the unit of affinity and, therefore, the hydrogen atom is a regular dodecahedron. Four such dodecahedra arranged in a pyramid represent the carbon unit: consequently, the dodecahedral units are distributed in two layers. The hydrogen atoms, in the fatty acids, are all brought down, as they are in the model of benzene, into these two layers: therefore, an upper and a lower face in the model are free carbon surfaces. The models can, in consequence, be superimposed at these faces and also interlocked at the sides. Verily, we have done well to use the name *paraffin*, not *sinaffin*. They can be joined, in the same plane, at the carboxylic ends and at the sides. To join them at the hydrocarbon ends, the models must be stepped, so as to raise one a layer above the other: this mode of packing is commonly met with in benzene derivatives. The attachment of the hydrogen units is peculiar, different from that adopted in our printed formulae, in that, although they occur in pairs, alternate carbon units carrying each a pair, both are on either one or the other margin of the model. These models, therefore, portray a new method of geometrical analysis, more powerful and intimate perhaps than any yet devised. It is further noteworthy, that although carbon surfaces are exposed, no complete carbon unit of affinity comes to the surface: whereas, in the model of benzene, there are three such affinities on each face.

From the measurements made by Langmuir and by Adam, we are led to conclude that the molecules of a fatty acid spread out upon water in single layers, so arranged that they stand upright, the carboxyl tip

dipping into the water, each upright molecule being closely fitted against its neighbours. The measured thickness of the thinnest black soap film is such that it may well be supposed to consist of two such layers, held upon a belt of water very few molecules thick, one standing upon the upper, the other depending from the lower face of the belt. Interpreting the film in this way, there is no reason to believe in the existence of a complex unit or micelle.

I can overlook sixty of the hundred years since Chevreul's invention. When I first studied chemistry, we were not entirely persuaded of the existence of atoms and were only beginning to form clear conceptions of molecular structure. We did not venture even to dream that we should ever be able to measure and speak with a close approach to certainty of the actual distances between atomic centres, which we now rate at little more than an Ångström unit, one hundred-millionth of a millimetre. Well might Chevreul say: "On doit tendre avec effort à l'infailibilité sans y prétendre": We seem to be near reaching it: though we can still make no claim to infallibility, we are probably far nearer to certainty than Chevreul ever thought possible. The methods which he did so much to make known and appreciated are the methods to which progress is due. As a result, the *bougie stéarique* is no mere illuminant to-day but something at which we can greatly marvel. The chemist can see massed in it wondrously built, tall staircases of atoms, up which the imagination may climb to infinite heights, seeing

..... successive zones
Of several wonder open on some spirit
Flying secure and glad from heaven to heaven.
Paracelsus.

Does the Solar Heat Stream Vary?¹

FIVE notable contributions to the literature of the "solar constant" have come recently from the United States: three, published by the Smithsonian Institution, give the evidence for variation in solar radiations and for the influence of that variation on terrestrial weather; the other two, appearing in the *Monthly Weather Review*, the organ of the Weather Bureau of the United States, contain critical analyses of the radiation statistics.

The first of these papers is an apologia by Prof. C. G. Abbot. He realises that critics have not been convinced hitherto that the fluctuations in the Smithsonian determinations of the "solar constant" represent real variations in the radiation received by the earth, and he sets out to marshal the evidence for variation in the most convincing way.

As a preliminary he narrows discussion by throwing over the earlier observations as too rough for the purpose in view. The paragraph is of such importance that it must be quoted in full:

¹ Washington, Smithsonian Miscellaneous Collections, vol. 77 (1925), No. 5: "Solar Variation and Forecasting," by C. G. Abbot; No. 6: "Solar Radiation and Weather or Forecasting Weather from Observations of the Sun," by H. H. Clayton; No. 7: "Solar Radiation and the Weekly Weather Forecast of the Argentine Meteorological Service," by Guillermo Hornmark. Washington. *Monthly Weather Review*, July 1925. "On the Question of Day-to-day Fluctuations in the Derived Values of the Solar Constant," by C. F. Marvin. *Smithsonian Solar-constant Values*, by W. W. Kimball.

Some writers mention our data for the past 10 or 15 years as if all were of equal value. Really, to speak in a figure, the Washington data of 1902 to 1907 were prehistoric. As for Mount Wilson results of 1905 to 1908, inclusive, before the invention of the silver disk pyrheliometer, or Fowle's method for estimating total atmospheric humidity... this work is ancient. Excluding altogether July and August 1912, the year of the eruption of the Katmai volcano, all Mount Wilson work of 1909 to 1920 can be classed as medieval. We had then but one station, operating only in summer. We obtained only one determination per day, subject to error from changes of sky transparency and also to errors of computing in the enormous multiplicity of computations used in the reduction of results by Langley's fundamental method. The period from January 1919 to the present is of another order of accuracy and represents the modern period.

It will be seen that it is only the comparatively short series of observations, those since January 1919, made mostly at Harqua Hala in Arizona, and of Mt. Montezumá in Chile, that need be taken seriously as evidence for rapid variations in the solar heat stream. Data for the greater part of this period, August 1920 to November 1924, have been published in a convenient form by the Smithsonian Institution (Misc. Collections, vol. 77, No. 3, Feb. 1925).

The average value of the solar constant is about 1.945 in terms of the unit in general use for this study, the gram calorie per square centimetre per minute. In other words, if the heat were all absorbed by a layer of water one centimetre deep, the temperature of the water would be raised 1.945° C. per minute.

In his discussion Abbot states that the average daily difference Harqua Hala minus Montezuma is only 0.011 units. This agreement has been attained, however, by an adjustment of the original readings by a process which has not been explained yet in print. It is clear that this process is calculated to minimise discrepancies between the stations.

Knowing the average difference between the approximately simultaneous observations, and assuming tacitly a Gaussian distribution, Abbot finds that the probable error of the daily measurement at either station is 0.0065 units. He proceeds to discuss the deviations from average in the estimates. These deviations are, it is true, of the same order of magnitude as the probable error. In the case of 398 estimates, each based on nearly simultaneous measurements at the two stations, the probable error is $0.0065/\sqrt{2}$ or 0.0046, and the number of such deviations exceeding 0.0046 is 214. The natural deduction would seem to be that the results show just as much consistency as would be expected if the solar heat stream really were constant and the deviations were due to errors of observation. There are, however, a few cases in which the deviations of the estimated radiation from the average are comparatively large. There are 6 deviations greater than 0.0245 units. With a Gaussian distribution of errors, the proportion of such large deviations would have been only 1 in 4000. Dr. Abbot seizes on this as strong evidence of real fluctuations in solar radiation. He suggests that the contrast between the extreme estimates and the ordinary run is comparable with that between the Washington Monument and the blades of grass around it. Dr. Kimball's remark that the determinations on which the extreme estimates are based are generally in the lowest grade of the Smithsonian classification, and mainly observations from one station only, seems more to the point. By a pair of telling diagrams Kimball shows that such correlation as exists between Montezuma and Harqua Hala values is due, not to any agreement in the variations during short periods, but to the large drop in the solar constant at one epoch. For October 1920 to March 1922 the average estimate at each station was 1.945, and for April 1922 to November 1924 it was 1.922. This contrast naturally dominates the situation when the observations of the four years are treated as a single group.

Thus the direct evidence for day to day variations in solar radiation is decidedly weak. Dr. Abbot supports his case, however, by evidence for an association of changes in radiation with the appearance of sunspots and faculae on the sun.

As to sunspots, this evidence is given in graphical form by Clayton. During the years 1918-1924 there were large sunspots, and the average values of the solar constant, reckoned for each of the 6 days before a spot passed the central meridian of the sun to 22 days after, fluctuate between 1.944 and 1.936. If the days are numbered -6 to +22, 0 being the day the

spot was on the meridian, it so happens that days 0, 1, and 12 are on the lower of these limits; days 9, 16, and 22 on the higher. The probable error of a single determination of the "constant" is supposed to be 0.0065 in the years for 1921 onwards. The earlier observations for 1918-1920 had much larger fluctuations. The probable error would average for the whole period at least 0.01. For a mean of 114 determinations the probable error would be about 0.001, so that variations for the mean up to 0.004 are scarcely significant. Moreover, Clayton's figures show no regular sequence. If they are accepted at their face value they indicate that a sunspot causes as violent fluctuations in radiation when it is on the far side of the sun as on the near side. We are forced to the conclusion that the analysis is worthless as evidence for the phenomenon Mr. Clayton wishes to establish, an association between the Smithsonian "solar constant" and sunspots.

Dr. Abbot and his colleagues have not been content to work at the improvement of their sunshine measurements. With the generous aid of Mr. J. A. Roebling, they have investigated the possibility of forecasting the weather by referring its changes to solar variations. The greater part of Mr. Clayton's paper is devoted to tables, graphs, and maps showing the average of pressure and temperature at various places so many days after high or low values of the solar constant. There is no attempt to show that the results are not attributable to chance, and indeed the general run of the graphs is in accordance with the hypothesis that they are.

Having reached this conclusion, how are we to explain the fact that Mr. Clayton can claim a considerable measure of success in forecasting temperature in New York several days in advance? Judging the forecasts by the departure of the mean temperature from normal, we see that when the forecast was "above normal" the average departure was actually nearly +1° F., and when the forecast was "below normal" the average departure was -1.28° F. The system of forecasting was based largely on the observation of sunspots and faculae: from these observations the solar constant was estimated and the subsequent pressure and temperature changes foretold. But Mr. Clayton did not trust to solar observations alone. "These were supplemented by the temperatures observed at Seattle, Withston, and Chicago, in order to ascertain to what extent the temperatures at American stations were responding to solar changes." Mr. Clayton will forgive us for thinking that his forecasts would have been equally successful if he had trusted to the weather telegrams and ignored the sunspots.

In Mr. Hoxmark's paper we have some account of the method adopted in the preparation of the forecasts which have been published at Buenos Aires for at least two or three years. The forecast published on a Wednesday gives the anticipated temperature at 8 A.M. and 8 P.M. for each day of the following week. As a sample of the results the paper includes a table showing the temperatures forecasted and observed for 12 weeks in the middle of 1924. If the reader takes the trouble to plot these figures he will find little correlation between forecasts and sequel. Calculations give 0.25 as the correlation coefficient in the case of 8 A.M. temperatures. As the standard value of a correlation

coefficient computed from the values of correlated variables is about 0.11, no importance can be attached to 0.25. For this particular period the forecasts must be regarded as a failure.

Mr. Hoxmark's own method of judging the points of his results is to find a correlation coefficient for each week. Of 131 weeks, 87 had positive coefficients and 44 negative. This disproportion must be counted as a point in favour of the forecasts. On the other hand, the fact that more than sixty per cent. of the week's forecasted yield correlation coefficients exceeding 0.3 is in no wise remarkable. Let it be noted that a correlation coefficient formed from seven pairs of samples is likely to be large even when samples are taken quite at random. The standard value of the coefficient derived from such samples is $1/\sqrt{6}$ or 0.41. In spite of the enthusiasm with which the results are recorded, we are left with the impression that these forecasts are not of practical value.

Thus the contention of Dr. Abbot and his collaborators that day-to-day estimates of solar radiation can already be used efficiently in weather forecasting would seem to fail. We have already seen that the reality of the fluctuations in solar radiation is itself highly problematical.

There is, it appears, a much stronger case for large

swings in the value of the solar constant, such as was found in 1922. The measurements show a notable reduction of so much as 1 per cent. in the radiating power of the sun as between 1920, 1921, and 1923, 1924. The possibility that such a change may be due to a failure to make complete allowance for some change in the earth's atmosphere is not to be overlooked. Prof. Marvin has brought out how difficult it is to be sure that the atmospheric effects have been eliminated. It is interesting to learn from Dr. Abbot that the solar changes are localised in short wave-lengths. The energy in the green, yellow, red, and infra-red was not affected by the 1922 drop; the effect was confined to the blue, violet, and ultra-violet. It is an obvious comment that this adds to the difficulty of accurate determination, atmospheric scattering being more serious with the short wave-lengths. To Dr. Abbot, a change, such as took place in 1922, indicates a reduction in the effective solar temperature, attending lessened solar activity, and the effects should be larger for shorter wave-lengths.

Let us accept this doctrine as a working hypothesis and look to its verification in the course of the sunspot cycle. At present most of the evidence available dates from the "medieval" era and therefore requires confirmation.

F. J. W. W.

Obituary.

PROF. WILFRID KILIAN.

CHARLES CONSTANT WILFRID KILIAN, whose death is announced at sixty-three years of age, was one of the most eminent of French geologists. For thirty-three years professor at the University of Grenoble, he was a man of enormous industry, his published papers and memoirs numbering nearly a thousand. The range of his work was very wide, but he is best known by his classic researches into the stratigraphy and tectonic structure of the French Alps, and by his palaeontological work, dealing chiefly with the Lower Cretaceous Cephalopoda; on this group he was acknowledged to be the leading authority.

Born at Schiltgenheim, in Alsace, in 1862, Kilian was educated at Strasbourg and at the Alsatian School in Paris, proceeding finally to the Sorbonne, where he was a contemporary of his lifelong friend and collaborator, Émile Haug. Here he was especially influenced by the teaching of Marcel Bertrand, and in 1885 served his apprenticeship in the field as assistant to this great Alpine geologist, on the expedition sent by the Paris Academy of Sciences to investigate the geology of Andalusia, following the great earthquake there. Three years later he presented as his thesis for a doctorate the "Monographie de la Montagne de Lure," a stratigraphical and palaeontological study which stamped him as a worker of great promise. The next year found him in charge of the school of geology at Grenoble, and from this time onwards his field-work was devoted entirely to the French Alps, where he toiled with untiring enthusiasm. Spending each summer vacation in the mountains, he can almost be said to have explored every inch from Provence to Mont Blanc, discovering many fossil localities, and bringing precise evidence to bear on the age and stratigraphical

relations of the rocks of this intensely complicated region. So enormous was the total of facts recorded by him that the titles of his papers occupy 25 pages of small text in the "Bibliographie géologique du sud-est de la France" compiled by him and a collaborator in 1922.

But never did the call of his field-work in the mountains detract from the care and accuracy of his palaeontological studies in his laboratory at Grenoble. Kilian's work on the phylogeny and ontogeny, and on the faunal succession, of Lower Cretaceous ammonites will always be considered classical, and his unique collection at Grenoble is one which many palaeontologists of the future will go there to see. In his rôle as ammonite specialist he was frequently called upon to report upon collections from other countries also, and so acquired an unrivalled knowledge of Lower Cretaceous stratigraphy. In the volume contributed by him to "Lethaea Geognostica" he attempted to bring this knowledge together into a comprehensive study. Three parts were published in 1907, 1910, and 1913, but the War intervened, and the work has remained unfinished.

Notwithstanding his immense scientific labours, Kilian never allowed himself to become too pre-occupied to fulfil thoroughly his duties as a university teacher. Under his influence the school of geology at Grenoble has become one of outstanding importance, and already some of his pupils rank among France's leading geologists. Many were the awards made to him in recognition of his services to science; finally, in 1921, he received the Gaudry Medal, the highest honour that can be awarded by the Société Géologique de France; and so, after a short and sudden illness, has passed away one whose name will always occupy an honoured place in the history of French geology.

L. R. C.

DR. J. R. HENDERSON.

DR. JOHN ROBERTSON HENDERSON, C.I.E., who died in a nursing home in Edinburgh on October 26, was an example of that "brotherhood between medicine and natural history in its widest sense" which has been a conspicuous product of the University of Edinburgh.

Born in Melrose in 1863, and educated at Dulwich College and Dollar Academy, Dr. Henderson graduated in medicine at the University of Edinburgh, and, influenced by the teaching of Sir Wyville Thomson, turned at once to those studies of marine animals which engaged his attention during the remainder of his life. He was one of the distinguished band of naturalists (which included Hugh Robert Mill, J. T. Cunningham, W. A. Herdman, and W. E. Hoyle) associated with Sir John Murray's oceanographical investigations after the return of the *Challenger*, first on *The Ark*, a canal barge anchored as a floating marine laboratory near Granton on the Firth of Forth, and later, on the steam yacht *Medusa* on the west of Scotland.

In 1886 Henderson was elected professor of zoology in Madras Christian College and relinquished that post in 1911, having, on the retirement of Mr. Edgar Thurston in 1909, been appointed Superintendent of the Madras Museum and Connemara Public Library and Keeper of the Marine Aquarium. On his retirement under the age limit a few years ago, he returned to Edinburgh and at once took part in the scientific activity of the city. At his death he was a fellow of the Royal Society of Edinburgh, and a member of council of both the Royal Physical and Scottish Zoological Societies. His experience in conducting and transforming the well-known Madras aquarium was of much service in the adjustment of the final arrangements of the large aquarium now being erected by the latter Society at the Scottish Zoological Park.

Henderson's zoological researches were almost entirely confined to marine invertebrates. As a result of his early years on the Forth and the Clyde, he made many contributions to the faunal lists of zoophytes, mollusca, echinoderms and crustacea of these areas, mainly published in the Proceedings of the Royal Physical Society. He was responsible for the account of the Anomura in the *Challenger* Reports, and continuing in India his work on crustacea, he described the Paguridæ collected by the *Investigator*. His most important work there, however, lay in the impetus he gave, by teaching and example, by his extension and development of the natural history section of the museum and of the aquarium, to the study of animal life in the laboratory, in the schools, and in the field.

Henderson was a man of wide interests; he wrote an excellent catalogue of the coins of Tipu Sultan, and his goodwill and the geniality which never flagged under the burden of ill-health gained him many appreciative friends in India and at home.

J. R.

DR. R. A. JOYNER.

DR. R. A. JOYNER lost his life as the result of an accident on Wednesday, October 7, through an explosion in the research laboratories of Messrs. Nobel's Explosives Co., Ltd. Dr. Joyner studied at University College, Bristol, taking a London degree with honours in

chemistry in 1909, followed by the M.Sc. degree of the newly founded University of Bristol in 1910. His work during this period is recorded in three papers on amalgams of silver and tin published in the Journal of the Chemical Society. These exhibit his careful and thorough experimentation and stand unaltered. They form the accepted basis of the treatment of dental amalgams in modern courses on dental metallurgy.

Joyner proceeded as an 1851 Exhibition Scholar to Zürich and afterwards followed Bredig to the Technische Hochschule, Karlsruhe, where he qualified for the degree of doctor of engineering, which has seldom been obtained by students from abroad. His exceptional ability and independent judgment were recognised by Bredig. He published two very pretty experimental papers, one on the affinity constant of hydrogen peroxide, the other on the catalysis of camphorcarbonic acids by bases in various solvents which further elucidated the remarkable parallelism between ordinary reactions and life processes, showing a mechanism through which optical activity may play its well-known rôle.

For twelve years Dr. Joyner served on the research staff of Messrs. Nobel's at Ardeer, and most of the important work which he carried out on such War-time problems as mustard gas and explosives is of course not available for publication, but an estimate of his unusual experimental skill and scientific acumen may be obtained from a study of the paper which he published in the Journal of the Chemical Society on the viscosity of solutions of cuprammonium.

Those who came in contact with Joyner must have realised that few scientific workers showed such wholehearted devotion and enthusiasm. He had many other interests, having been versatile in athletics and being a keen Territorial officer for many years. His straightforward and unassuming personality gained him not only esteem but also affection from all who knew him. In spite of the tragedy of his loss at the age of thirty-eight years, his widow and three children can look back with pride on his devoted work in the cause of science.

WE regret to announce the following deaths:

Sir Alfred Woodley Croft, K.C.I.E., president in 1892-93 of the Asiatic Society of Bengal and sometime trustee of the Indian Museum and Vice-Chancellor of the University of Calcutta, on October 29, aged eighty-four years.

Dr. Theodor Fuchs, corresponding member of the Vienna Academy of Sciences and honorary director of the geological and palæontological section of the Natural History Museums in Vienna, on October 5.

Dr. Carl Kupelwieser, honorary member of the Vienna Academy of Sciences, and a founder of the Institute for Radium Research at Vienna and of the Biological Station at Lunz, on September 16.

Mr. H. B. Mullen, Director of Museums and Libraries, Salford, and formerly an assistant in the Art and Ethnographical Department, National Museum of Ireland, on October 26, aged sixty-three years.

Mr. M. J. Nicoll, formerly assistant in the Zoological Gardens at Cairo, the author of numerous ornithological papers published chiefly in the *Ibis*, on October 31, aged forty-five years.

Dr. Henry H. Robinson, superintendent of the Connecticut Geological and Natural History Survey since 1920, on October 20, aged fifty-two years.

Current Topics and Events.

ON Thursday, November 12, a small company gathered in the entrance hall of the Royal Institution of Great Britain to witness the unveiling of the memorial to Sir James Dewar, who for forty-six years was director of the Institution. Mr. H. Munro Ross, chairman of the memorial fund committee, described the inception of the fund, and stated that although Dewar himself wished for no memorial, it was felt that a commemorative plaque in the Royal Institution, his home for so many years, and the scene of some of his best work, would meet with general approval. Mr. Munro Ross then asked the president of the Royal

spectacular demonstrations. In Sir Joseph's view, Dewar's greatest achievements were the liquefaction of gases on a large scale, thus making possible their use as physical agents, and the use of charcoal cooled by liquid air for the production of high vacua. This work has proved to be of fundamental importance in experimental research on the structure of matter.

THE recent visit of Sir Ernest Rutherford to Melbourne, at the instance of the University authorities there, is described in news-cuttings from the Melbourne *Argus* which have reached us. We understand that the Melbourne visit was part of a programme organised jointly by more than one of the Australian universities, and that Sir Ernest had already visited Adelaide, and was proceeding to Sydney, thence going on to New Zealand, his native country. The immediate purpose of the invitation was to enable serious students, researchers, and teachers in physical science to meet and to hear—in some cases, for the first time—one of the prime movers of their own work; and it is evident, from the clearly reported meetings and lectures described in the news-cuttings, that this object was attained so successfully that it cannot fail to yield valuable fruits, directly and indirectly. At the same time, as members of the British Association who travelled to Australia eleven years ago will not need to be told, warm hospitality was shown to the president-elect of the Royal Society, even outside academic circles; and he also came into touch with those concerned in radio transmission, and with medical radiologists.

THE great stimulus of personal intercourse with the comparatively few living pioneers in science is one which comes fairly easily and frequently to the members of British universities, who may thus tend to forget what an extraordinary encouragement and impulse is brought by each such occasion. It will be interesting, therefore, to learn whether the Australian institutions which have arranged this fruitful visit of Sir Ernest Rutherford meditate any plan of making such invitations at regular intervals. High though the cost of a visit is, it would not fall heavily if divided between several universities of the Dominion at intervals of a year or two. To be selected as the "Dominion Lecturer for 19—" would become an honour, for which even the busiest of the most eminent leaders should willingly devote time and energy. The English long vacation falls in the term-time of the Southern Hemisphere, and the necessary additional month or so of leave should present little difficulty. We do not see why such a scheme need be restricted to the branches of science, for historians, economists, and others would no less benefit. It seems certain that a plan of this kind would form a real network of thought and action among British universities and would lead to valuable interchanges of all sorts.

THE Stockholm correspondent of the *Times* has telegraphed that the Nobel Prize in Physics for 1924 has been awarded to Prof. K. M. G. Siegbahn, of the



Institution, His Grace the Duke of Northumberland, to accept the plaque as a perpetual memorial to Sir James Dewar and his work at the Institution, and to unveil it. The Duke of Northumberland acknowledged the gift on behalf of the Royal Institution and performed the unveiling ceremony, revealing the relief here illustrated of Sir James Dewar seated before his laboratory bench. Thus Dewar is added to the group of notable men of science connected with the Royal Institution whose memorials grace its entrance hall, and its position, on the main staircase opposite the entrance, ensures that all comers will see the likeness of one who was not the least of those who have directed its activities. After the unveiling ceremony, Sir J. J. Thomson gave a brief address on Dewar and his work. He referred to the originality and forcefulness which were characteristic of Dewar's methods, and also spoke of his genius for devising

University of Upsala, for his work on spectrum analysis. The Prize in Physics for 1925 has been reserved, while the Prizes in Chemistry for both 1924 and 1925 have also been reserved. As the Prize in Chemistry for 1924 has thus remained unawarded for two years, the money must either be added to capital or used to form a special fund for promoting scientific research, independently of the annual prizes. Accordingly the 1924 Prize has been assigned to the reserve fund of the chemical section of the Nobel Institute.

ALL who are interested in the trend of modern atomic theory will welcome the announcement that the Nobel prize for physics for 1924 has been awarded to Prof. Manne Siegbahn of Upsala. When the prize was instituted it was intended as a recognition of outstanding experimental work, and Prof. Siegbahn is, first and foremost, an experimentalist. His most notable researches, and those for which the award has been made, have been in X-ray spectroscopy. Since Moseley's first measurements, the technique has been improved to such an extent that it is now possible to measure wave-lengths in this region of the spectrum to six significant figures. This advance is due, almost entirely, to the work of Prof. Siegbahn. In addition to these high precision measurements, he has made an exhaustive study of the soft radiations which lie between the ultra-violet and the ordinary X-ray region. These researches have made possible the theoretical work on which practically all our knowledge of the distribution and energy properties of the electrons in the atoms is based. The complete and accurate data now available have led to the identification of three new elements, hafnium and the two eka-manganeses, while another application which originated and is being pursued in the Upsala laboratories is the investigation of the effect on the X-ray spectrum of an atom of its different states of chemical combination. This work promises to throw much light on the distribution of the electrons in the molecule. It is certainly fitting that experiments which have led to such an important increase in our knowledge should receive recognition, and the new Nobel laureate is to be congratulated on a well-deserved honour.

THE long-awaited particulars of the projected re-organisation of the British Dyestuffs Corporation, Limited, were announced on Saturday, November 14, in an official communication to the shareholders. As anticipated, Government control is to be abolished and the capital of the company is to be drastically reduced. The company states that experience has proved that the restrictions imposed by the Government seriously militated against the successful conduct of business, and the Government has agreed to withdraw its veto and control provided that the company purchases its share interest of 1,700,001*l.* for the sum of 600,000*l.* in cash, communicates to the Government all necessary information concerning technical matters and research, and that the old restriction of not issuing more than 25 per cent of the company's shares to foreigners, remains in force. The proposals, which are to be submitted to a meeting

of shareholders on November 25, also include the writing off of nearly one-half the issued capital to cover depreciated assets, and the conversion of the three classes of shares into a single denomination. The authorised capital is to remain at 10,000,000*l.*, but not more than 6,000,000*l.* will be issued unless by resolution of the shareholders. If the proposals are accepted, the issued capital will be 4,775,580*l.*, all of which will be in the form of ordinary shares, and the sum of 1,667,185*l.* will be available as working capital. The accounts for the period of 17 months to March 31, 1925, show a profit of 88,674*l.*, after providing 437,832*l.* for depreciation. In view of the preponderance of plant capacity over consumption in all dye-producing countries, it is interesting to note that the board proposes to engage in the manufacture of "other products."

DR. KNUD RASMUSSEN, in an address to the Royal Geographical Society on November 9, gave an account of his travels from Greenland along the north coast of Canada to Alaska and across Bering Strait to Siberia. In the course of this journey of three and a half years' duration, he had opportunities to explore fully the routes of migration and the culture of various tribes of Eskimos. On the shore of Lake Yathkied, about three hundred miles south-west of Chesterfield Inlet he discovered an unknown inland tribe of Eskimos, ignorant of the coast life of tribes farther north and living in primitive conditions which suggested that they may be a remainder of the aboriginal Eskimos. In places along the north coast of Canada, Dr. Rasmussen found other Eskimos still using bows and arrows and in a state of isolation so complete that no word of the War had ever reached them. As a rule they were very shy of white men, and turned out fully armed to meet the explorers. In several of the tribes it is the custom to put to death nearly all girls at birth, but in other respects they are kindly and well-disposed. Dr. Rasmussen came on traces of the Franklin expedition of 1845-48. He met an Eskimo whose father had seen several of Franklin's men and had visited his deserted ships at King William Island. The bones of two of Franklin's men were found, one in King William Island, the other at Starvation Cove in Adelaide Peninsula. These were men who had fallen in the retreat towards the Great Fish River.

A SPECIAL meeting of the Institution of Chemical Engineers was held on Thursday, November 12, for the discussion of the report of the British Science Guild on "Scientific Research Workers and Industry," referred to in our columns on September 26. The president, Sir Frederic Nathan, took the chair, and the Hon. H. Fletcher Moulton opened the discussion and pointed out that although the proportion of science students in Great Britain has increased above the 1914 standard by 60 per cent, it is still only equal to the pre-War proportion for the United States and Germany. In spite of this, many research workers are unable to find posts. There is also an unfortunate tendency to belittle technical research in favour of fundamental research. The great problem is to combine efficiently university training with

factory work at some early period of a student's career. In the discussion which followed, a number of interesting points were brought out. For achieving the desired combination of practical experience and theoretical knowledge, it was suggested that the scheme followed by the Chemical Engineering School of the Boston "Tec," in which training classes under a responsible teacher are regularly held in several works for six months at a time, might be adopted. The importance of good industrial experience as part of the lecturer's qualification was also discussed. Many research workers are, indeed, really more suited for the works laboratory than for the more academic type of research. The discussion of the activities of research associations revealed the fact that the average cost to a firm of belonging to a research association is about the price of one office boy. In spite of the excellent results obtained, however, successful research associations tend to break down by the large firms forming their own research departments.

Two Chadwick public lectures on "The Control of the Food Supply" were delivered by Dr. William Howarth at the Royal Sanitary Institute on October 30 and November 6. In the first lecture, statistics were given illustrating the enormous amount of food imported into Great Britain, and the general principles controlling the supervision of imported food were reviewed. The importance of refrigeration in relation to food supply was emphasised, and it was suggested that local authorities ought to be vested with certain powers of control over cold-storage. Recent regulations designed to ensure greater cleanliness in the handling of meat, etc., will probably fulfil their aim, though the control of stores and shops presents difficulties not easy of solution. As regards the milk supply, considerable improvement might be effected. The control of pasteurised milk is unsatisfactory, as the official term "pasteurised milk" may be used only under licence, but this fact does not deter unlicensed persons treating milk by pasteurisation or sterilisation and selling it in bottles either as "milk" or as "heat-treated milk," or by any other designation so long as it is not an official one. Publicity may have given the impression that the food supply is deplorably unhygienic, but in Dr. Howarth's opinion this is not so, and the position in general is one that may be regarded as reasonably satisfactory, with room for improvement in certain directions. In the second lecture, the subject of milk was further considered. Dr. Howarth pointed out that the definition of cream in the "Preservatives Order" is unsatisfactory, and that cheese is another produce for which no declaration of composition is required, unless it is margarine cheese, with the result that remarkable variations in the fat content occur. The manufacture of canned foods was explained, as well as the method of inspection and sampling applied to them. Other subjects dealt with were eggs, ice, ice-creams, and the use of preservatives in food-stuffs. As regards the last-named, reference was made to the difference of opinion existing as to the harmfulness of such substances as boric acid, and

Dr. Howarth expressed a doubt as to whether benzoic acid would prove to be an efficient substitute for boric acid.

We have received from the Central School of Science and Technology, Stoke-upon-Trent, a catalogue of its ceramic library, which includes the well-known collection of the late L. M. E. Solon. Solon was for thirty years in the service of Messrs. Minton, and was an indefatigable collector of ceramic literature. Since his death the collection has been acquired by a gift of 2000*l.* from the Carnegie United Kingdom Trust, and its deficiencies made good by a further gift from the same quarter—the Trust stipulating that the Library should be regarded as a national institution and that its contents should be available (under proper safeguards) to other than the inhabitants of the district. The printing of a catalogue of the collection thus became a necessity. The catalogue is an author catalogue with appendices of (a) catalogues and (b) periodicals, but this arrangement the student is left to discover for himself. Moreover, the classification is not strictly carried out. Catalogues of books, for example, will be found in all three sections. In other respects the cataloguing methods adopted are not satisfactory. The grouping of anonymous works under the general heading ANON is contrary to accepted practice. Biographical references are not appended to author headings. Hence the student must examine each entry in the author section if he wishes to consult the literature which has appeared around the names of Palussy, Tinworth or Wedgwood. The work, however, is well printed and will, no doubt, be useful to those interested in the literature of ceramics and glass.

In the course of a lecture to the students of the Royal Academy of Arts, London, on Wednesday, November 18, on the selection of stone for building, Prof. A. P. Laurie divided the stones which are used for building into two groups—sandstones and limestones. The most serious cause of weathering to-day is the attack on the stone of the acid oxidised products of sulphur, and this is not confined to the towns. The action of the sulphur acids results in the formation in the case of limestones, and in the case of sandstones, which contain calcite, of calcium sulphate, which is slightly soluble in water. The most serious effect of calcium sulphate is its crystallisation within the stone, resulting in the stone being mechanically broken up. Some sandstones are practically free from calcite, and these should be used in modern cities. Limestones differ considerably in susceptibility to attack and in tendency to break up, owing to the crystallisation of the sulphate of lime. Apparently one of the conditions is that there should be free and rapid evaporation from the stone after wetting, so as to draw the sulphate of lime to the surface and prevent it from crystallising inside the stone. This raises the question as to whether the hosing of buildings during hot weather would not be of advantage. Further research is required in these directions, but in the meantime it was quite possible to guide the architect in the selection of sandstones and lime-

stones by chemical analysis and by experiments on the rate of attack of acid vapours upon samples of the stones

It is precisely one hundred years ago since the *Memoirs of Samuel Pepys*, F.R.S., Clerk of the Acts, were first edited by Lord Braybrooke, from a version of the shorthand manuscript in Magdalene College, Cambridge, which had been deciphered by the Rev. John Smith of St John's College. The private thoughts and confidences of few persons have been more widely read and quoted than those of the versatile Mr. Pepys. He has illustrated the actions, feelings and sentiments of his contemporaries with such a wealth of detail that it is difficult to believe that the diary only covers the years 1659-1669, but as those ten years cover the period of the foundation of the Royal Society, it is very pleasant to receive a reminder of the scientific side of the great diarist, "a great cherisher of learned men," in the form of an article in the October issue of the *Quarterly Review*, from the genial pen of Sir Arthur Shipley. It is surprising to learn that Pepys had had no early preliminary education such as we now expect of a man of science. He reached his thirtieth year before beginning to learn the first four rules of arithmetic, but then an hour on a July morning sufficed for a good beginning with the multiplication table, an accomplishment which he afterwards used to distract and instruct his wife. By associating with the leading men of science of the day he became a scientific amateur of the best type. Always receptive, always interested, unspoiled by over-education, he did a vast amount of good by encouraging others.

An organisation for encouraging the study of natural history in China was formed at a meeting held on September 21, in the lecture room of the department of anatomy, China Medical Board, Peking. In his opening remarks Dr. A. W. Grabau, who was the enthusiastic promoter of the movement, enumerated the existing scientific organisations in China, and stated that he felt that there was a need for a new natural history society. Dr. W. H. Wong, Mr. R. Chapman Andrews, and Mr. Walter Granger also spoke in hearty approval of the organisation of the proposed society. Following a brief discussion, it was decided to adopt the name, "The Peking Society of Natural History." The object of the society is the promotion of the study of, and the spread of interest in, the natural history of China. The following officers have been elected for the coming year: *President*, Dr. G. D. Wilder; *Vice-Presidents*, Dr. W. H. Wong and Mr. Sohtsu G. King; *Secretary-Treasurer*, Mr. N. Gist Gee; *Council*, Dr. A. W. Grabau, Prof. S. C. Lee, Dr. R. K. S. Lim, Dr. H. H. Tan, Dr. Davidson Black and Mr. K. K. Chung. Upon the completion of the organisation of the society, Dr. Wilder addressed the meeting upon the subject "Some Common Birds of Peking." Dr. Wilder had a number of mounted specimens of Chinese birds, and coloured plates of closely related American birds. An interesting feature of the illustrations was some copies by Mr. Kungpah King

of ancient Chinese paintings of birds. These were so accurate that in many instances the birds can be identified from them.

MR. L. C. M. S. AMERY, Colonial Secretary, has written to Sir William Thiselton-Dyer congratulating him upon the completion of the "Flora Capensis." An account was given of the inception of this work and the conditions under which it has gradually advanced to completion, in *NATURE* of September 26, p. 474.

At the annual general meeting of the Cambridge Philosophical Society, held on Monday, October 26, the following officers for the session 1925-1926 were elected:—*President*, Prof. J. T. Wilson; *Vice-Presidents*, Mr. C. T. Heycock, Dr. G. T. Bennett, Mr. G. Udny Yule; *Treasurer*, Mr. F. A. Potts; *Secretaries*, Mr. J. Gray, Mr. F. P. White, Mr. R. H. Fowler, *New Members of Council*, Prof. G. H. F. Nuttall, Dr. J. Chadwick, Mr. H. Munro Fox, Mr. W. B. R. King, and Mr. P. M. S. Blackett.

At the annual general meeting of the London Mathematical Society held on November 12, the following officers for the session 1925-1926 were elected:—*President*, Prof. A. L. Dixon; *Vice-Presidents*, Prof. S. Chapman, Mr. J. E. Littlewood, and Mr. H. W. Richmond; *Treasurer*, Dr. A. E. Western; *Librarian*, Prof. H. Hilton, D.Sc.; *Secretaries*, Prof. G. H. Hardy and Prof. G. N. Watson; *New Members of Council*, Dr. W. E. H. Berwick, Mr. R. H. Fowler, and Mr. E. C. Titchmarsh.

At the annual general meeting of the Junior Institution of Engineers held on November 13, the following officers were elected:—*Chairman*, Mr. A. J. Simpson; *Vice-Chairmen*, Messrs. R. L. Kirlew and C. E. Atkinson; *Hon. Treasurer*, Mr. C. O. Hourant; *Hon. Librarian*, Mr. T. W. P. Mullings; *Members of Council*, The Master of Sempill, and Messrs. S. Dunlop, E. D. Gill, and D. B. Skinner.

THE Peterborough Natural History and Archaeological Society has acquired for its Museum the collection of fossils made by the late Mr. P. J. Phillips from the Oxford Clay of the neighbourhood. When Mr. Alfred N. Leeds died in 1917, Mr. Phillips continued his work in collecting fossil reptiles and fishes, but he was much handicapped by the introduction of steam diggers in the brickfields. Under difficult conditions he obtained several fine specimens, including a unique example of the rare ganoid fish *Heterostrophus*.

THE fifth International Congress on Genetics will be held in Berlin during the latter half of September 1927. Those who attended the fourth Conference in Paris, 1911, will remember that a meeting in Berlin was then planned for 1916. The invitation, which now comes from the German Society for the Study of Heredity, has been unanimously accepted by the six surviving members of the International Committee appointed by the Paris Conference. The arrangements are in the hands of Prof. E. Baur, president of the German Society, with whom are associated Profs. Correns, Goldschmidt, Hartmann, and Nachtsheim.

SIR ARBUTHNOT LANE directs attention in the *Fortnightly Review* for November to the importance of good health and the prevention of disease to the nation as well as to the individual. It is estimated that sickness imposes a burden of 500,000,000l per annum upon Britain in the form of lost earnings alone. Sir Arbuthnot Lane ascribes much ill-health to wrong feeding by the use of over-refined and over-manipulated foods. In order to renew the health of the nation, some medical and non-medical men have founded "The New Health Society," which proposes to begin a nation-wide campaign, and all those who are able and willing to help are requested to communicate with the Secretary at Sentinel House, Southampton Row, W.C.1.

At the annual general meeting of the Philosophical Society of the University of Durham, the following officers and committee were elected.—*President*, The Chancellor of the University; *Vice-Presidents*, Sir Theodore Morison, Sir Chas. A. Parsons, Dr Irvine Masson, Dr A. Robinson, Prof. Havelock, and Mr Wilfred Hall; *Secretaries*, Mr. J. W. Bullerwell and Dr. G. C. Leith; *Editor*, Dr. G. W. Todd; *Librarian*, Dr. F. Bradshaw; *Chairmen and Secretaries of Sections*. (Chemistry and Physics) Mr. P. L. Robinson and Mr. Clarkson; (Geology and Biology) Dr. K. B. Blackburn and Dr. Allan; (Mathematics) Mr. J. L. Burchinal and Mr. Colbourne; (Archæology) Dr. J. Wight Duff and Dr. J. L. Morison; (Applied Science) Dr. Morrow and Dr. Baker; (Philosophy) Prof. Ferguson and Mrs. Alderson.

We learn that the London Mathematical Society intends to publish, in addition to its *Proceedings*, a second periodical entitled *The Journal of the London Mathematical Society*, which will be issued in four

quarterly parts of about 64 pages each, and will be sent free to members. There can be no question that there is room for such a journal, for there is little periodical literature available in the field of mathematics. The new *Journal* is therefore assured of a wide welcome. Its contents will, in the main, consist of original contributions to knowledge, but the papers printed in it will be short and will be selected, so far as possible, from those most likely to appeal to a wide circle of readers. The *Journal* will also contain records of proceedings at meetings, abstracts of papers, obituary notices, and other matters of interest to members. The first part will be published in January next. All business communications should be addressed to the publisher, Mr. Francis Hodgson, 89 Farringdon Street, London, E.C.4.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Two investigators under the Safety in Mines Research Board for research work in connexion with wire ropes used in coal mines—Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (November 27). A temporary advisory officer on farm economics under the Board of Agriculture for Scotland—Secretary, Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh (November 30). A professor of philosophy in the University of Bristol—Registrar (February 1). A glassblower at the University of Birmingham—The Professor of Chemistry, The University, Edgbaston, Birmingham. A chief mechanic and instrument maker for the chemical department, University College, Gower Street, W.C.1—The Secretary.

Our Astronomical Column.

A THEORY OF STELLAR EVOLUTION.—Dr. J. H. Jeans contributes a further paper on this subject to the Monthly Notices of the Roy. Ast. Soc. (vol. 85, No. 9). It is concerned with the question of stability, and the directions in which it may break down. In the case of the hottest stars a limit of output of energy is reached when, say, 99 per cent. of the nuclei are stripped of all their electrons. A limit on the side of smaller temperature is fixed in the case of the giants by the development under certain conditions of very large pulsations, such as are conjectured to be present in Betelgeux. In the case of the dwarfs it is concluded that at a certain point in their cooling, rapid contraction occurs, and they end their stellar career in a state like that of the companion of Sirius. But Dr. Jeans notes that unless these stars have very slow initial rotations, the acceleration of rotation that accompanies contraction will cause fission, accompanied by a rise of surface temperature. The end may thus be postponed for a season, but it is only delayed. A geographical analogy is used which enables some of the results of the paper to be stated very concisely. The stars are plotted with ordinate denoting absolute magnitude and abscissa spectral type. They group themselves over an area shaped something like North and South America, but with a widened isthmus of Panama. The giants are in North America, the Pacific coast being the line where 99 per cent. of the electrons have been stripped from the nuclei. The

Plaskett star is appropriately located near the Victoria Observatory. The Canadian Atlantic coast is occupied by the M giants like Antares, the red dwarfs being much lower down.

The masses of the stars are indicated by graphs that are very nearly parallel to the lines of equal absolute magnitude, showing that Dr. Jeans now regards the law of dependence of absolute magnitude on mass as being a fairly close approximation to the truth.

THE NEW 200-INCH MAP OF THE MOON.—This large map of our satellite will be issued, as stated in NATURE of June 13, in sections measuring 22 by 30 inches. The following will be available for distribution by about the end of December, at a price of 4s. per section: Copernicus Region, Tycho R., Mare Crisium, Sinus Iridum, Clavius R., Pitatus R., M. Australe and Plato R. Copies of these, and also of the 60-inch map already published, may be obtained of the author, Mr. H. Percy Wilkins, 46 James Street, Llanelly, South Wales. It is intended that the map shall include every known object on the lunar surface, and the details have been represented with a very careful regard to accuracy. Selenographical literature has been ransacked for details, and every effort made to ensure correctness. The Mount Wilson photos have also been consulted, and the author himself has made a number of telescopic observations which have supplied useful evidence as to certain formations.

Research Items.

MAORI ROCK CARVINGS.—An interesting discovery which will probably prove of some importance in Polynesian ethnology is announced by the Wellington (New Zealand) correspondent of the *Times* in the issue of November 11. Two members of the State Forest Service have discovered a series of rock carvings in a shallow cave 4 ft to 12 ft. deep, 7 ft. high, and extending for a distance of about 80 ft. along the base of the cliff at the edge of the Kaingaroa Plains near Rotorua. Rough bas-reliefs of canoes, some thirty in all, grouped in fours or singly, were found on the back wall of the caves. The canoes vary from 3 ft to 8 ft. in length. A point of considerable interest in them is that while they have high stern frames, the bows differ entirely from the Maori form of canoe in having a beak on the waterline, and a high boarding platform. A further point of difference is that the carving on the sides is in the form of a double spiral instead of the single spiral of Maori art. Dr. Buck, the well-known Maori authority, apparently does not regard this difference as necessarily of fundamental significance, and thinks that the people who made the carvings were at least related to the Maoris. So far, the evidence of human habitation in the caves is confined to the stones of a primitive oven and a stone pestle used for pounding fern-root. It is suggested that this cave may have served as a refuge for the Ngatihotu tribe who inhabited the wide central area of North Island and were dispersed some time after the Maori immigration of the fourteenth century.

THE NORSEMEN—In the *Dalhousie Review* for October, an article by Mr. Victor Plarr surveys some of the evidence for the extension of Norse influence in the tenth and eleventh centuries A.D. A much-disputed question in this connexion is that of the identity of "Vinland," colonised from Greenland by Torfinn Karlsefne in 1003. In the year 1000 A.D. (a year to which Mr. Plarr erroneously assigns the coronation of Charlemagne), Leif, son of Erik the Red, the coloniser of Greenland in 982 A.D., had already reached the mainland of America. Torfinn's colony soon came to an end, possibly, owing to the attacks of natives, the "Skraelings." Mr. Plarr accepts the view that identifies Vinland with Nova Scotia, the "grapes," which the Norsemen are said to have found being, it is suggested, mountain cranberries. He also agrees that the natives with broad faces and ugly hair were Eskimo. This description might equally well apply to some of the Indian tribes, now extinct, who inhabited this part of North America. Mr. Plarr refers briefly to the subsequent history of the Colony of Greenland which died out, the Norsemen being either exterminated by the Eskimo or more probably, he holds, absorbed by them through intermixture. Mr. Plarr, however, does not refer to the very interesting discoveries made in the course of excavations in the graveyard of the Church at Herjolfsnes and described by Nørlund, Hansen, and Jónson in *Meddelelser om Grønland*, vol. 67, 1924, which throw considerable light on Norse culture in Greenland. They included arms, clothes, and personal ornaments, as well as skeletal remains, and a remarkable collection of small crosses in very large numbers.

SNAILS OF THE GENUS PARTULA.—In a publication by the Carnegie Institution of Washington (Publication No. 228a, March 1925), Dr. H. E. Crampton gives the results of a close study of the variation, distribution, and evolution of the genus *Partula*, in the Mariana Islands, Guam and Saipan. This is the

second memoir by the author: the first, published in 1917, dealt with the species of Tahiti. The present volume is illustrated with fourteen plates, four of which consist of beautiful coloured illustrations of the four species inhabiting the islands. The work contains important observations on the ecological characteristics of the Mariana Islands. Though the researches are biological in character, the author discusses the pertinent geological problem as to the prior existence of a great land-mass, or group of land-masses, in the western and southern Pacific Oceans, and from his present studies of the genus *Partula* he concludes that subsidence has been the general process by which an ancient land-mass with a widespread parental stock has been converted into lesser disconnected areas upon which occur the isolated daughter stocks. Some interesting details are given concerning the geological nature of the habitats and the breeding habits of the snails. *Partula salifana* (a new form from Mount Salifan in Guam) has a remarkably heavy shell, though it occurs in a region where no limestone exists. Conversely, *P. fragilis*, which lives in the northern part of Guam, in a calcareous region, possesses an extraordinarily thin and diaphanous shell. From these and other instances it is clearly evident that character of soil is not a factor influencing the density of the shell. *Partula fragilis* also produces eggs before the flaring lip of the aperture (the conventional sign of maturity) is constructed. Further, in contrast with its associates of the Mariana Islands, its egg-capsules are fully impregnated with calcareous salts. The eggs are also remarkable for their great size relative to the size of the parent shell.

MIOCENE SHELLS FROM TRINIDAD.—The object of Mr. W. C. Mansfield in a recently published paper (Proc. U.S. Nat. Mus., 66, Art. 2) is to describe some inadequately known Miocene Gastropoda and Scaphopoda from Trinidad, and to fix the exact geological horizons of the localities whence they were procured. Out of some 92 species considered, 58 are described as new, while 13 remain indeterminate. The ten plates in illustration of 72 of the species are exceedingly well done.

EXTINCT PROBOSCIDEA—In the Proceedings of the American Philosophical Society for 1925 will be found Prof. H. F. Osborn's "Final conclusions on the evolution, phylogeny and classification of the Proboscidea." These conclusions Prof. Osborn himself describes as "very startling and novel to those conservatives who would embrace all the two hundred and ninety odd species described from all parts of the world in two genera, namely, *Mastodon* and *Elephas*." He divides them into twenty-eight genera, which are arranged in polyphyletic lines. In a pamphlet of twenty-eight pages it is not to be expected that the author should enter into detailed reasons for his views, and palaeontologists will await with interest Prof. Osborn's forthcoming monograph on the group.

RAISED CORAL REEFS OF THE RIUKIU ISLANDS AND TAIWAN (FORMOSA).—Coral reefs raised to heights of from 10 to 684 feet above sea-level are found extensively in these islands of Japan. They are nearly horizontal and rest unconformably on Palaeozoic or Tertiary sediments or on igneous rocks. The age of these reefs is discussed by H. Yabe and S. Hanzawa (Science Rep. Tôhoku University, Sendai, ser. 2 (Geol.), 7, 2, 1925). The fossils include numerous species of Foraminifera, Polyzoa, Brachiopoda and Mollusca. The Foraminifera, of which the more important forms are described and figured in this

memoir, differ considerably from those now living in the adjacent seas and suggest that the reefs are of Pleistocene or earlier date; but they are not likely to have been formed during the Glacial Period, since, according to Daly, even so far south as the Hawaiian Islands, the temperature was then too low for reef-building corals to flourish. The evidence at present available suggests that these reefs are either of late Pliocene or early Pleistocene age.

SWEDISH METEOROLOGY—Among recent publications of the Statens Meteorologisk-Hydrografiska Anstalt is Part 4 of the *Arsbok* containing the meteorological observations taken at Swedish stations during 1922, including data collected at several lighthouses. Altogether there are about two hundred meteorological stations. The data from twenty of these are given in full, from some forty the monthly and annual means are given, and from the remainder the monthly and annual temperature means alone. Another annual Swedish publication of interest is *Observations Météorologiques à Abisko en 1916*. For this station in lat $68^{\circ} 20' N$ the observations are given in full. A further contribution to the hydrographic survey of Sweden is contained in Dr G. Wersén's paper on the Lulälven in the series entitled *De Svenska Vattendragens Arealförhållanden*.

THE PASSAGE OF ELECTRONS THROUGH CRYSTALS.—An investigation of the Hall effect produced by applying a magnetic field at right angles to the direction of the photoelectric primary current in diamond and zincblende is described by Dr H. Lenz in the *Annalen der Physik* for September. Two small electrodes touched opposite edges of the elongated crystal through which the current passed, and the magnetic field was at right angles to the broader faces. The sign of the difference of potential between these electrodes caused by the magnetic field was in the case of diamond that demanded by the theory of electronic deflexion. With zinc sulphide it was often reversed and a number of experiments were made in an endeavour to discover the reason, but neither the orientation of the crystal nor want of uniformity in the illumination accounted for the anomalous results. A theory is developed for the normal effect by means of which it is possible to calculate the free path λ and velocity v of the electrons. In one observation with a field intensity of 4000 volts and a magnetic field of 4000 gauss, the Hall effect was 62 volts; this gave $\lambda = 3.4 \times 10^{-8}$ cm. and $v = 6 \times 10^8$ cm./sec. for diamond. The lattice cell of this substance is of the order of 10^{-8} cm., so that the electron does not move from one molecule to the neighbouring one but through a greater distance. Values for normal observations with zinc sulphide are of the same order of magnitude. Observations were made with part of the crystal kept dark, and it was shown that the small current which passed through the dark parts was not caused by diffuse reflected light. No alteration in the diamagnetism of diamond was found when it was illuminated, as seemed possible theoretically. Experiments were made as to the production of conductivity by shooting electrons into the crystal, and others on the photoelectric current at the temperature of liquid air.

THE RAYLEIGH SEISMIC WAVE—In a paper in Part 5 of Vol. 2 of the *Japanese Journal of Astronomy and Geophysics*, H. Nakano discusses the effect of a seismic disturbance in the interior of an elastic solid bounded by a plane face and otherwise extending to infinity. The problem, which is treated in two dimensions only, is an extension of Prof. Lamb's classical investigation of the disturbance arising from a surface pressure. Reference was made to the paper

in NATURE of July 4, p. 27, and, as was remarked there, it is shown that the Rayleigh wave does not appear in the neighbourhood of the epicentre, and at no place is marked by a sudden beginning. At greater distances, the time at which it becomes prominent corresponds to the time taken to traverse the distance measured from the epicentre (and not from the focus). The following further details are of interest. When the initial disturbance is such as would give rise to both compressional and distortional waves, two systems of Rayleigh waves are formed. If the velocities of these three kinds of wave are respectively V_1, V_2, V_3 , the disturbance of the first system is not appreciable at epicentral distances less than $V_3 f / (V_1^2 - V_3^2)^{1/2}$, where f is the depth of focus, the other system first becomes important at distances greater than $V_2 f / (V_2^2 - V_3^2)^{1/2}$. At distances less than this latter, the separation of an L phase from P and S phases will be almost impossible, as at distances between these values the Rayleigh wave (of the first system) arrives between the P and S waves. When this result has been extended to three dimensions, a comparison of records obtained near the epicentre may throw some light on the question of the depths of earthquake foci, but the problem will be greatly complicated by the existence of the granitic layer, which necessitates taking into account the formation of Love waves.

URINARY ANTISEPSIS—The problem of the destruction of harmful micro-organisms in living tissues can only be satisfactorily solved with the discovery of substances which are germicidal when acting in the tissues of the body and at the same time are quite innocuous to the latter. The majority of known antiseptics also injure or destroy the tissues in certain dilutions, so that attention has been directed to the finding of compounds which will exert a specific effect on the organisms in concentrations far removed from those which are toxic. A further complication has arisen from the fact that many substances which are bactericidal in watery solutions lose much of their activity when acting in media containing proteins, such as the body fluids. Moreover, for efficient action in the body, it is frequently necessary for the compound to be conveyed to the site of action by the bloodstream, so that to be of any general use it should be capable of administration by the mouth, being subsequently absorbed in the intestine. In the case of the urinary tract, where, especially in the upper parts, the local application of antiseptics is not easy, the compound must also be one which is excreted through the kidneys. Hexamine, given by mouth, produces formaldehyde in acid urine, but effective concentrations tend to be irritating to the mucosa. V. Leonard (*Jour. Amer. Med. Ass.*, 1924, vol. 83, p. 2005) has been investigating the antiseptic properties of a series of alkyl derivatives of resorcinol and has found that the hexyl compound is forty-five times as efficient an antiseptic as phenol, and yet is comparatively non-toxic. When administered by mouth, it is absorbed in the intestine and excreted in the urine, chiefly in conjugation with some other substance, but also in small quantities unchanged; the urine acquires definite bactericidal properties. When tested clinically in cases of chronic urinary tract infection, it was found to destroy organisms such as the *Staphylococcus* and *B. coli*, and, except in cases with heavy infections of the latter, the urine became sterile after a variable period. The real value of the substance can only be determined after prolonged clinical trial; but the early results suggest that a useful urinary antiseptic has been discovered. Hexyl resorcinol has been put on the market by The British Drug Houses, Ltd., under the name of "Caprokol."

Engineering in Steel Works and Collieries.

THE presidential address of Sir William Henry Ellis, delivered at the Institution of Civil Engineers on November 3, was devoted to a survey of the varied and difficult problems arising in steel works and collieries connected with the great development in mechanical engineering which has taken place during the last forty years. In the early part of this period, steel works engineering was in the hands of good practical men who could only with difficulty move with the times, owing to their lack of knowledge of the technical side of engineering. Low pressure steam was supplied to distant mill and machine shop engines with inevitable waste. Electricity probably did not exist in any of the large steel works. High-speed tool steel was unknown, except Mushet steel, used more for its power of dealing with unexpectedly hard material than as high-speed steel is now used. There was, therefore, a great opportunity for young engineers who had received a combined technical and practical training to share in the work of introducing improved machinery. Economic production was not then so important, and there was comparatively little foreign competition.

The introduction of much higher steam pressures with water-tube boilers, and the advent of electricity, have been the two factors of the greatest help to steel-works engineers. To illustrate the advance—thirty years ago a large machine shop, with its inefficient driving and steam generation and distribution, was converting 15 per cent of the total energy of the coal into useful work. Now, by taking power from one of the latest and most efficient super power-stations in Great Britain, the shop can convert 17.38 per cent of the thermal energy of the coal into useful work. This represents less than one-fifth of the energy available, and hence engineers cannot yet feel satisfied.

Developments in marine engineering caused the introduction of hollow rolling. Up to the time of the *ss Lusitania* turbine drums had been nearly all welded. Sir William was able to apply a process of punching and hollow rolling to the production of drums, in some cases more than thirty tons in weight. The process has revolutionised this important industry, and the results have been entirely satisfactory. What has always been wanted for this purpose has been a satisfactory ingot, cast hollow. At present Sir William and his colleagues are interested in experiments in this direction by means of centrifugal

casting, this point being mentioned as an instance of the importance of the metallurgist and engineer co-operating in the closest possible way.

The physical properties of steel begin to change at temperatures at which steam is now used—750° F and higher, and Sir William is carrying out a research on this point, with his metallurgical colleague Dr W. H. Hatfield. The results of the series of tests being made will be useful to engineers who have to deal with the very high steam pressures employed. If still higher pressures with their corresponding temperatures are introduced, it may be necessary to use alloy steels, the physical properties of which are only affected at much higher temperatures.

No engineers are more definitely entrusted with the lives of their subordinates than mining engineers. Such engineers must possess an extremely varied knowledge, and it is very difficult for the mining engineer of a large colliery to be conversant with all the modern developments in mechanical engineering. Immense progress has been made in recent years in colliery engineering, but much remains to be done, and Sir William urges the desirability of the mining engineer having well-trained mechanical engineers on his staff. Such could render very great assistance to their chief.

Electricity has as yet been introduced into collieries only to a limited extent. No doubt electrical engineers may aid its use by further reducing the liability to sparking. Oil-immersed switches in closed boxes are a considerable safeguard, and the well-thought-out designs of main cables now in use appear to afford great security against risk of short-circuiting in cases of falls of roof. Electric haulage in the workings has largely replaced the practice of surface engines with haulage ropes in boxes down the shafts. Electric winding has been introduced, and is making considerable progress.

Reference was also made to the work of the British Engineering Standards Association, which has now 475 committees and 2300 members. Engineers have shown great public spirit in giving time and attention to this great work—entirely on an honorary basis. Engineers and steel firms throughout Great Britain have generously supported the work by contributions to the funds, but this is a severe tax on industry in the present state of things, and it is earnestly hoped that some measure of Government help may be forthcoming.

The Ignition of Gases.

MANY of the difficulties connected with the ignition of gases are still unfathomed, although the subject has been investigated in one way or another from the time of Davy's well-known researches connected with safety in mines. Measurements of the rate of combustion were first attempted by Bunsen, but it was left to Berthelot, to Le Chatelier, and to Dixon to lay down the methods by which the propagation of combustion in gases could be satisfactorily studied. A further impetus to such investigations came with the development of the internal combustion engine. The recent work of Bone, which indicates that nitrogen plays a considerable part in the process of combustion, is particularly interesting and links the subject with the fixation of nitrogen. It was apt, therefore, that a discussion on the subject should have taken place at the meeting of the British Association at Southampton between the Chemistry and the Engineering Sections.

Prof. H. B. Dixon opened the discussion with a historical survey of the subject. He described Berthelot's discovery of the detonation wave and Le Chatelier's experiments on the same subject at the same date. Le Chatelier discovered three stages of combustion, the stage of uniform propagation, developing into a vibratory type of combustion which precedes the last stage, the initiation of the detonation wave. Prof. Dixon illustrated his remarks by some of his beautiful photographs of the propagation of explosions in mixtures of oxygen with cyanogen, acetylene, and other gases. The explosion wave travels with uniform velocity at the speed at which sound would travel in the gas, taking into account its high temperature and state of compression due to the combustion. Experiments on the measurement of ignition temperatures, which he has recently carried out by two different methods, were described. Tizard and Pye have shown that the delay which

may occur before ignition when a combustible mixture is suddenly compressed adiabatically, depends on the temperature coefficient of the gaseous reaction. Ignition occurs when the heat evolved by the ignition of a gas just exceeds that lost to the surroundings. For the purpose of their experiments, Tizard and Pye used a variable compression machine with a piston which could be stopped by a toggle joint as soon as the gas had been compressed to the desired amount. Prof. Dixon described a similar arrangement by means of which the ignition point of electrolytic gas has been found to be continuously lowered as oxygen is added, in agreement with Le Chatelier's earlier experiments. With methane-air mixtures there is first a lowering, then a rise of the ignition point. It may be mentioned that Tizard and Pye, on the other hand, have found that for heptane-air mixtures the ignition temperature is only changed some 8°C when the heptane-to-air ratio is increased from 1 to 10. Prof. Dixon showed some interesting photographs of explosions occurring in gases compressed by his falling weight method, the combustion does not proceed from a point, but spreads out from an undefined region of luminosity.

The second method used by Dixon for the determination of ignition points depends on allowing a stream of inflammable gas to meet a stream of oxygen or air heated to the same temperature. This is effected by means of two concentric tubes surrounded by electric heating arrangements and so arranged that the gases can be introduced under high pressure or at reduced pressures. So long as the temperature is above a certain point, the gases on meeting ignite at a certain distance from the orifice of the tube. Increase of pressure as a rule decreases the temperature of ignition, but in the case of hydrogen, decrease of pressure also lowers the ignition temperature, even down to a pressure of one-tenth of an atmosphere.

Prof. David described his work on the effect of radiation on the rate of combustion of gas mixtures in a closed vessel. He finds the radiation which is effective is that which is absorbed by the combustible gas, but that no speeding up occurs if there is no nitrogen present. The radiation 4.4μ is absorbed by carbon monoxide and speeds up the combustion of carbon monoxide, oxygen, and nitrogen, while 3.2μ radiation is absorbed by methane and speeds up the combustion of methane, nitrogen, and oxygen mixtures. If the nitrogen is replaced by argon, oxygen, or carbon dioxide, no speeding up occurs. The rate of rise of pressure measured by means of an optical indicator determines the amount of the speeding up. The effect of radiation is shown not to be due to the inhibition of formation of oxides of nitrogen. Prof. David suggests that the radiation

tends to inhibit the temporary association between the nitrogen and the combustible gas, which normally occurs according to his view. Bone has found that nitrogen plays a considerable part in combustions at high pressures, the rate of combustion being much slower when nitrogen is present, the effect being attributed to "activation" of the nitrogen. There result considerably greater amounts of oxides of nitrogen than otherwise would be expected.

When ignition of a combustible mixture occurs in a closed vessel, the rate at which the flame spreads depends on the rate of communication of ignition from layer to layer of the gas and the rate at which the mixture moves under the expansive force of the burning gas. Dr. O. C. Ellis described the method by which he has studied this phase of the subject; work which has been undertaken for the Safety in Mines Research Board. A mechanically controlled camera is arranged to take a series of photographs of the advancing flame, the final photograph has the appearance of being divided into alternate dark and light zones, the exposures being intermittent. For weak mixtures—mixtures near the limit of ignitibility—the lightness of the burning portion compared with the surrounding unburnt gas together with the convection currents which outrun the flame and return upon it, determine the propagation and spread of the flame. For stronger mixtures, burning first occurs at nearly constant pressure; in this case the effect of the enclosure makes itself manifest and the flame moves to the more open space. If there is an opening the flame will move towards it. In a spherical vessel with central ignition, the flame would spread as if to reach all parts of the wall at the same time, but if convection currents have time to influence the combustion, the spread will be quicker in the upward than in the downward direction.

A glow has been found to occur in the flame products and lasts longer than the time taken for the primary flame to spread throughout the vessel. The duration of the afterglow appears to vary with the amount of water present; the glow is greater when argon is used as a diluent rather than when excess of carbon monoxide or nitrogen is present. The glow appears to be due to burning of combustible gas which has escaped the passage of the flame. It is not mainly due to oxidation of carbon monoxide, because in mixtures of oxygen and excess of cyanogen, brilliant periods of residual burning are found.

The incompleteness of combustion and the continuance of processes of combustion after passage of the flame was one of the points brought out by this discussion. Another point, which will no doubt repay further investigation, was the very considerable part played by nitrogen in processes of combustion.

Ornithologists at Berlin.

THE seventy-fifth anniversary of the German Ornithological Society was celebrated in Berlin on October 3-7. The meeting was more like a congress, nearly two hundred members attending, including representatives of eight different countries, in addition to those from all parts of Germany. The programme was full and varied.

On the first evening of the celebrations, an opening address was given by the president, Dr. von Lucanus, and the addresses and congratulations from the ornithological societies of other countries were read and presented. Dr. Ernst Hartert and Mr. Gregory M. Mathews represented the British Ornithologists' Union. Dr. Stresemann compared the status of

ornithology in 1850 and 1925. The lectures referred chiefly to Mediterranean and African ornithology. Lonnberg (Stockholm), on the influence of periods of climate on the African ornith. Spatz (Berlin), on Crete, Hartert (Tring), on Atlas and Sahara, Reiser (Vienna), on the present knowledge of the ornith. of the Balkans; Koenig (Bonn), on the White Nile; Heck and Neumann (Berlin), on Abyssinia, and so on. Other lectures were concerned with bird-migration. Geyr von Schweppenburg (Munden), Drost (Heligoland), Drescher (Ellguth), especially the results of ringing, with systematic studies and distribution: Kleinschmidt, Freiherr von Berlepsch and others, and ecology. Heyder (Oederan). Most interesting

and valuable were Dr. Heinroth's reports on the rearing of many species of birds from eggs, illustrated by lantern pictures. The rest referred chiefly to local German ornithology (Schlott and others).

Many wonderful nature-photographs and films were shown on the screen, among the latter the remarkable "Ufa" films of bird life in Brazil (humming-birds nesting, taken by Baron Dungern), in Abyssinia, East Africa, on the Kurische Nehrung (the ornithological station at Rossitten), and on bird migration, also the medieval method of catching thrushes on migration, which is almost extinct now, only lingering in one place in Westphalia. A striking figure among the ornithologists attending was the ex-King Ferdinand of Bulgaria, whose wide and varied knowledge astonished all those who did not know him. Dinners and luncheons concluded the meeting, as well as inspections of the Zoological Gardens and the Aquarium, the model from which the larger London Aquarium has been built. Last but not least, a flight in aeroplanes took place over the forests and swamps of the Mark Brandenburg, Dr and Mrs. Heinroth explaining where rare birds, such as cranes, various species of *Locustella*, and others, were breeding. E.-H

University and Educational Intelligence.

CAMBRIDGE.—The School of Biochemistry built by means of funds from the trustees of the late Sir William Dunn has during the last few years found difficulty in maintaining itself on its endowments. The demands of biochemical research are bound to be somewhat extensive in material, and its materials are expensive in character. The same trustees recently gave 2000*l* per annum to the Medical Research Council for the next five years; the Council has investigated the accounts of the Biochemical Department, and as a result has forwarded 500*l* towards the maintenance fund of the School.

An extension of the Fitzwilliam Museum is proposed, this extension has been rendered possible by the generosity of two anonymous benefactors who have provided 50,000*l*.

LONDON—Two free public lectures on "The Efficiency of the Heart and its Measurement" will be given by Prof. Y. Henderson, of Yale University, at University College on November 30 and December 1, at 4.30. On December 4, at 5 o'clock, at St. Thomas's Hospital, Prof. F. G. Parsons will give a free public lecture on "The Earlier Inhabitants of London."

MANCHESTER.—Mr. William Myers, formerly Director of Weaving, has been appointed professor of textile technology in succession to Prof. F. P. Slater, who has resigned.

The Council has received the resignation of Dr. Henry Stephen, senior lecturer in chemistry, on his appointment to the chair of organic chemistry in the University of the Witwatersrand, Johannesburg.

The following have been elected Honorary Research Fellows: Ann Bishop, in zoology; Anthony Claassen (Amsterdam), in physics; Dr. H. Raymond Ing, in chemistry; J. N. Ray (Calcutta), in chemistry; Dr. J. C. Smith, in chemistry.

The Knight Travelling Scholarship in Psychological Medicine has been awarded to Mr. L. C. F. Chevens

THE East London College gives particulars in its Calendar for 1925-26 of the School of Dramatic Study and Research recently established by the College Council. The Faculty of Engineering offers, in addition to the usual civil, mechanical, and electrical engineering courses leading to the B.Sc. degree of the Uni-

versity of London, a three-years' course in aeronautical engineering.

WE learn from *Science* that the will of the late James B. Duke, former president of the American Tobacco Co., provides 8,000,000*l* for Duke University, Durham, N.C., 800,000*l* of which is to be used for the establishment of a medical school and hospital. This amount is in addition to the 8,000,000*l* given to Duke University last December by Mr. Duke, to which reference was made in these columns (*NATURE*, December 20, 1924, p. 916).

THE Board of Architectural Education, which, under the Council of the Royal Institute of British Architects, controls education in architecture through the Institute's examinations, has recently been reconstituted in order to make it fully representative of all such educational interests throughout the British Empire. The R.I.B.A. is already in very complete touch with all architectural problems through its allied societies, which represent the profession in specific areas embracing the whole of Great Britain. The Board proposes to delegate executive powers to three committees concerned with schools, examinations, and prizes and scholarships respectively, confining its own work to matters of policy and principle. In addition, there will be a small body of moderators who will deal with the details of the examinations. The numerous schools of architecture and allied arts, polytechnics and art schools concerned, H.M. Board of Education, the Headmasters' Conference, the London County Council and several other bodies, will have seats on the board, which should thus form a very powerful and representative organisation able to stimulate the work of the schools by its visiting committees and to function in the best interests of students and the art and technique of architecture by securing a requisite uniformity in examination matters and educational policy.

THE University of British Columbia, which has long outgrown the quarters in Vancouver City in which it has carried on its work since its establishment in 1915, celebrated on October 16 the opening of its new buildings on the magnificent site, comprising 548 acres on the headland which forms the western extremity of the Point Grey Peninsula, granted for the purpose by the provincial government in 1911. The ceremony was presided over by Sir Arthur Currie, Principal of McGill University, to which Vancouver College, the nucleus of the University of British Columbia, was affiliated from 1899 until 1915. The new buildings, which have cost nearly two million dollars, consist of three permanent units—the science block, library, and power house—and nine semi-permanent, designed for a life of forty years. Among the latter are an applied science building for departments of geology, botany, zoology, forestry, and civil engineering, an agriculture building accommodating departments of agronomy, animal husbandry, dairying, horticulture and poultry, a mechanical and electrical engineering, a mining and metallurgy, and a forest products building. There are at present but three faculties—Arts and Science, Applied Science, and Agriculture. The number of students enrolled in 1924-25 was 1451. The University is in the fullest sense a State institution. It is an integral part of the public educational system of the province, and its policy is "to promote education in general, and in particular to serve its constituency through three channels—teaching, research, and extension work." A principal aim of the extension work is to inform the people of the province of the results of special work by the staff. Last year the provincial legislature granted 480,000 dollars for the upkeep of the University.

Early Science at Oxford.

November 22, 1687. Some letters were read from Mr Cluner with Mr President's answers concerning the squaring the Circle, and Parabola. Some moulds of old coins were communicated by Mr Musgrave sent by Mr. Hughs out of Somersetshire. Some stones communicated by Mr Musgrave taken out of the ureters of a man, being 7 small ones, and one very larg being an inch long, and above an inch round. An account of the dissection of Mr. Castillion who dyed of a universal Tabes, and cancer of the Stomach, was also communicated by Mr. Musgrave.

November 23, 1683. Mr Piggot informs ye Company, that filing takes off ye attraction of iron; as, he says, was found true by a late experiment; but this was afterwards found to be true, onely when ye Iron was filed *all over*. Dr Plot tells us farther, that of 22 sorts of Iron-ores, which were dug in Sussex, and he has by him, not one applies to ye magnet. It was ordered to be tried whether a peice of this ore will apply after a very great Calcination? as also whether a magnet, and peice of iron, being put into Mr Boyle's Pump, and ye air exhausted, will draw one ye other? A Catalogue of Bodies Electricall was ordered to be brought in. 'Twas ordered to be tried, whether electricall bodies will operate, as such, in vacuo. Severall of ye stones belonging to Mr Ashmole's Musæum, were examined, as to their Electricity; A sapphire, a Bohemian granate, a spinall ruby, a balass ruby, and a hyacinth were observ'd to be electricall.

Dr Pit was pleased to promise, that ye next time we met, he would give an account of some experiments relating to Digestion.

November 23, 1686. Mr R P, vicar of Kildwick in Yorkshyre, sent an account of a strange *eruption of waters*, June 1686, in Craven.

An account was communicated from one Tho. Wells in Oxford who cures himself of the *Gout* by drinking Beer, wherein mustard-seed has been Steeped.

He likewise gives us an account of the great *herring fishing* trade lately begun in Summersetshire, by ye coming of the Herrings up the Severn which was not known before this year.

All things were prepared by Mr Caswell for observing ye Eclipse on the Friday night, but the cloudinesse of the night hindred him from makeing any observations.

Dr. Plot communicated an account of a monstrous *Cucumber* growing in the garden of Dr Wm Jacob at Canterbury. Ye length was 3 foot ten inches and a quarter, ye girth circumference 9 inches.

November 24, 1685. An Experiment was tried before ye Society which shewed, that 12 ounces of water was enough to buoy up a vessell of more than two pounds weight, so that ye vessel did plainly swim. This experiment was made use of to confirm ye 10th Prop: of ye 4th book of Stevinus's Staticks concerning ye different pressure of ye same quantity of water in vessells differently shaped.

A Description of a new sort of Pump was read. The contriver of it has made some tryall of it, and thinks it will be usefull, where there is occasion to pump much water, and especially in deep pits.

Dr Plot shewed us ye *Corallum Album Fistulosum* of Ferrante Imperato; and another Corall with fine small threads of a dark red not described by any, that we know of. He also shewed us an egge of the Sea-Tortoise, which was somewhat bruised, but seemed to have been exactly globular, and a piece of whitish substance very light, called cream of Soap, said to be made by ye nuns of Prussia.

Societies and Academies.

LONDON

Royal Society, November 12.—Sir William Bragg and R. E. Gibbs: The structure of α and β quartz. The original investigations upon α quartz left four unknown parameters, namely, the distance of the silicon atoms from the trigonal axis and the spatial relations of the oxygen to the silicon atoms. One parameter could be estimated from the results of intensity measurements, but more data were required. At 573°, α quartz undergoes a transition to the β hexagonal variety, probably with little structural change. If, therefore, the β structure could be determined, that of the α would become nearer solution. The evidence of theoretical calculations and of X-ray rotation photographs of quartz above its transition point shows that in the β structure the oxygens surround the silicon atoms tetrahedrally, and that the spirals parallel to the principal axis are formed by alternate atoms of silicon and oxygen. Atomic dimensions are consistent with the normal values, and the structure agrees with requirements. The structure is consistent with the development of pyro- and piezo-electricity and compatible with the theory of electrical conductivity.—Lord Rayleigh: The light of the night sky: its intensity variations when analysed by colour filters. (i.) The observations now extend over nearly 2½ years. The intensities of the various chromatic components of the light undergo important variations when measured against a fixed terrestrial standard, and the components also undergo considerable relative variations when measured against one another. Attention is primarily concentrated on the spectral region transmitted by a screen designed to isolate the green auroral line as nearly as possible. Notwithstanding the definite relative variations, this auroral intensity is highly correlated with the intensity in the orange-red region, not so highly with the blue region, and still less with the photographic region centred near $\lambda 4300$. The values found for the correlation coefficients are: Aurora-red, 0.70, Aurora-blue, 0.66, Aurora-photographic, 0.44. On the other hand, the auroral intensity is not correlated appreciably with the degree of magnetic disturbance or the height of the barometer. The connexion with the sun-spots, if any, is not yet apparent. The intensity does not vary measurably with the sun's distance below the horizon, within the limits, evening and morning, when twilight is excluded. Parallel observations of the auroral intensity at Pasadena, and at Mt. Wilson, California, are, in the mean, more than double those prevailing in England.—W. A. Bone and G. W. Andrew: Studies upon catalytic combustion. Pt. 1. The rate of combination of a (moist) theoretical mixture of carbon monoxide and oxygen ($2\text{CO} + \text{O}_2$) in contact with a gold surface in a "normal" state of activity at 300° C or thereabouts is always proportional to its pressure. The "normal" catalysing power of the surface at such a temperature can be (a) greatly diminished by either keeping it at the room temperature for some days or prolonged evacuation of it at 300° C, or (b) highly stimulated by previous exposure to either of the two reacting gases at 300° C. Whenever, starting with the surface in a state of "normal" activity, either one or other of the two reacting gases is present in excess, the subsequent rate of combination, which rapidly becomes "supernormal," is always proportional to the partial pressure of the carbon monoxide. It is considered that an "activation" occurs of both of the combining gases of the surface, which is not confined to superficially "adsorbed" gas-films of monomolecular thickness, but extends also to more deeply occluded gases.—O. W. Richardson

and F. C. Chalklin: The excitation of soft X-rays. When the curves between efficiency of X-ray emission and primary voltage using a photo-electric method are plotted, a number of abrupt changes of slope are observed. Within the range 40-600 volts, four such discontinuities, of which the lowest one is complex, have been observed for carbon, 13 for tungsten, 10 to 13 for nickel, and 15 for iron. Some of these discontinuities are due to the excitation of characteristic X-rays and allied phenomena. The total X-radiation per electron impact is approximately proportional to the square root of the atomic number, for the target elements tested, and to the square of the energy of the impinging electrons.—R. Campbell Thompson: On the chemistry of the ancient Assyrians. Ashurbanipal's library of clay tablets inscribed in cuneiform in the seventh century B.C., excavated at Nineveh and now preserved in the British Museum, included tablets now in 24 fragments, giving the native Assyrian receipts for making glazes, glass, and their colours. The first section of these chemical texts describes the furnace for the glass, the magical formulae necessary, and the fuel of *Styrax-logs. The next few sections detail the ingredients for making the celebrated blue glaze, first with a frit of 10 parts sand, 15 alkali, and $1\frac{1}{2}$ *Styrax-gum, followed by copper-scale, prepared by heating, and the subsequent directions for its admixture. Glasses were of three kinds: *surcu* (60 parts sand, 180 alkali, 5 salt(petre), 2 chalk); *dushu* (crystal) (60 sand, 180 alkali, 6 salt(petre), $\frac{1}{2}$ chalk, 3 oxide of tin (?), 3/10 oyster shell (?)), and *zuku* (components mutilated). The most interesting receipt is to make 'bahrā'-stone (red coral (?)), approximately 7200 parts of *zuku*-glass, 32 oxide of tin (?), 20 antimony, some salt(petre), and 1 part of gold, which suggests the well-known Purple of Cassius.—J. E. Lennard-Jones: On the forces between atoms and ions. The repulsive fields of 20 atoms and ions have been determined. Applications of the results are made to evaluate the interatomic distances of 32 crystals, including 16 alkaline halogens. In the case of the latter, the calculated values are found to lie, with one exception, within 1 or 2 per cent of the observed distances.—F. G. Mann and Sir William Pope: β , β' , β'' triaminotriethylamine and its complex metallic derivatives. The preparation of triaminotriethylamine hydrochloride from bromethylphthalimide has been improved. This amine acts as a tetra- or as a tri-acidic base, according as the tertiary nitrogen atom exerts or fails to exert its basicity. Consequently, two distinct series of aurichlorides, platinumchlorides, and rhodochlorides have been prepared. Co-ordinated derivatives of the base with divalent and tetravalent metals have been prepared: in all these compounds the amine acts as a tetracidic base, and satisfies four co-ordination valencies of the metallic complex.—K. R. Ramana-than: The structure of molecules in relation to their optical anisotropy. Pt. II.—E. V. Appleton and M. A. F. Barnett: On some direct evidence for downward atmospheric reflection of electric rays. In a study of signal variations at short distances (18-100 miles) from a short-wave transmitter, by changing the wave-length of the transmitter continuously through a small range, interference phenomena were observed, indicating the existence of two or more rays. Experiments made at Cambridge on the signals from London (2LO) have shown that the signal variations are greater on a loop antenna than on a vertical aerial, the ratio of the variations indicating that the direction of propagation of the down-coming waves makes an angle of 65°-70° with the ground. The existence of down-coming waves has been demonstrated at distances of 18 miles from a transmitter, which indicates that the ionised layer reflects waves at almost

normal incidence. The rays returned from the upper atmosphere are of complex polarisation, as is to be expected according to the magneto-ionic theory of wave propagation, and are of sufficient intensity to be responsible for the directional errors experienced in short-distance transmission. An inferior limit for the number of electrons per cubic centimetre in the ionised layer is 10^6 .

Royal Microscopical Society, October 21.—R. J. Ludford. Short osmic acid methods for the demonstration of the cytoplasmic inclusions of cells. After a number of experiments carried out with the view of shortening the technique previously described, shorter methods have been worked out, which give quite as satisfactory results. The tissue is fixed in corrosive-osmic, and the osmication is carried out with 2 per cent. osmic acid at 30° C., for three days, followed by water at the same temperature for another day, to complete the reduction of the acid. An alternative method is to begin the osmication in 2 per cent. osmic acid at 35° C., and dilute daily with an equal quantity of distilled water. At the end of the third day transfer to water also at 35° C. After sections have been cut, mitochondria can be stained by the modified acid-fuchsin method already described.

Physical Society, October 23.—H. E. Smith: The influence of strain on the Thomson effect. For piano-forte steel, charcoal iron, constantan and nickel, the Thomson coefficient numerically decreases with tension until the elastic limit is reached, after which it increases. With removal and restoration of tension a new definite cycle is followed. The Thomson effect in tungsten, here measured for the first time, increases with tension and also follows a cycle. No change is noticed in brass or German silver. Heterogeneity was not present in the specimens investigated.—W. Mandell: The measurement of temperature by thermocouples in unequally heated enclosures. In doing this, the recorded temperature depends upon the thickness of the couple, the nature of the walls of the enclosure and the nature of the gas. An explanation is suggested based upon the fact that the amount of radiation received and emitted by a couple depends upon its position in the enclosure, and that the amount of energy transferred to it by molecular impact varies with the nature of the gas.—W. Clarkson. On the flashing of certain types of argon-nitrogen discharge tubes. Discharge tubes having various types of electrodes, and in which the filling gas, a mixture of argon and nitrogen, had a wide pressure range, were used. At higher pressures the discharge is no longer of the "glow" type, but takes place between definite points on the electrodes.

Royal Anthropological Institute (Indian Section), October 27.—S. M. Edwards: The population of Bombay City. remarks on its origin and growth. The history of the City falls into five well-defined periods, each of which contributed certain distinct elements of population. During the first four periods Bombay consisted of seven separate islets, which were welded together during the fifth or English period. The prehistoric period contributed the fishing-population of Kolis and their aboriginal goddess, whose title has given the name Bombay to the city and western presidency. The second or Hindu period, which lasted until A.D. 1300, witnessed the arrival of the Parsis and Beni-Israel in Western India, as well as the mixed Mohammedan population, resulting from the union of Arab traders and refugees with Hindu women of the coast. The rule of the local Silahara chiefs was responsible for the immigration of various castes of Hindus, notably the Pathars, Prabhus and Panchkalshis, and probably also, the

Bhandaris, who cultivate and tap the liquor of the coco-nut palm. During Mohammedan rule the famous shrine of the Saint at Mahrin was established, while under the dominion of the Portuguese (A.D. 1524-1661) the Bombay population was considerably reduced and dispersed by the proselytising tyranny of the Portuguese religious orders, their only contribution to the population being the native Christian and Indo-Portuguese or "Topass" elements. The customs of some of these converts present an interesting study. The real growth of population commences with the arrival of the English in Bombay, and can be traced to certain definite political and domestic events, including the steady reclamation of the island from the sea, and the foundation of the local textile industry. In A.D. 1660 the population was said to be 10,000, to-day it numbers more than one million, including persons from all parts of India and Asia, Europe, Africa, and America.

CAMBRIDGE

Philosophical Society, October 26.—Sir Ernest Rutherford and W. A. Wooster. The natural X-ray spectrum of radium B—C. D. Ellis and W. A. Wooster: (1) The atomic number of a radioactive element at the moment of emission of the γ -rays. The atomic number found in the case of radium B (82) is 83, and in the case of radium C (83) is 84. Since both these bodies disintegrate by emitting an electron from the nucleus, these results show that the γ -ray emission occurs after the actual disintegration. (2) The β -ray type of disintegration. In a β -ray disintegration the γ -rays are emitted after the electron has left the nucleus. This result is discussed and a general picture given of the β -ray type of disintegration.—D. H. Black. The analysis of the β -ray spectrum due to the natural L-radiation of radium B—D. R. Hartree: Doublet and triplet separations in optical spectra as evidence whether orbits penetrate into the core. The separations of terms of all available doublet and triplet spectra are compared with Landé's formula, which is derived on the assumption that the orbit of the series electron penetrates into the core. If in any actual case the orbit does not penetrate, no agreement is to be expected. The results agree in most cases with the assignment of quantum numbers proposed by Bohr; except for lithium-like atoms, all p -terms correspond to penetrating orbits.—H. F. Baker. On the reciprocation of one quadric into another—P. A. MacMahon. The enumeration of the partitions of multipartite numbers—R. H. Fowler. Assemblies of imperfect gases by the method of partition functions. Theorems of statistical mechanics in a mathematically simple form, applying to assemblies of isolated systems, such as perfect gases or single crystals, are extended to imperfect gases, where the free atoms and molecules continue to act on one another with forces of short but not negligible range, and again with long range forces obeying the inverse square law. We thus recover in a new setting the usual results of the theory of van der Waals, and examine the basis of the important combined use of Boltzmann's and Poisson's equations.—J. P. Gabbatt. Note on the pedal locus.—L. H. Thomas. An extended form of Kronecker's theorem, with an application which shows that Burgers' theorem on adiabatic invariants is statistically true for an assembly.—W. F. Sedgwick. On the series of forms of Jacobi's rotating liquid ellipsoid.

DUBLIN.

Royal Irish Academy, November 9.—Kenneth C. Bailey: The estimation of aldehyde in alcoholic liquors by means of Schiff's reagent. The estimation,

as usually performed, often gives very inaccurate results. The development of a colour from Schiff's reagent and alcohol, which is apparently not due to aldehyde originally present, is noted, and possible explanations suggested. A reliable technique for the estimation is proposed.

LEEDS.

Philosophical and Literary Society, November 3.—C. K. Ingold. Structural relations of natural terpenes. Utilising the principle that gem-dialkyl and allied groupings appear in natural compounds only in such positions that they stabilise the structure, the number of possible natural terpene structures is shown to be limited and to conform to all recorded observations, except one—the alleged occurrence in Nature of sylvestrene.—J. Ewles. The luminescence of solids. The lines along which the theory of luminescence of solids is being developed are indicated. It is suggested that the slight trace of impurity necessary for luminescence enters into the crystal lattice of the substance in the form of solid solution. The impurity nuclei, with their linked solvent atoms, are supposed to act as the radiating system.—G. F. Brett. The photographic effect of slow electrons. For slow electrons ordinary films and plates are unsuitable and a method is described in which a fluorescent substance in the form of a thin layer of special grease is applied to the film. By this method, electrons having speeds of at least 65 volts and upwards can be registered photographically.—H. M. Dawson and J. S. Carter: A contribution to the study of the ionisation of strong electrolytes. The solubility of iodine in sodium chloride solutions of widely varying concentration shows that the halogen combining capacity of the salt is independent of its concentration. The condition of the dissolved salt thus appears to be unaffected by change of concentration in agreement with the theory that strong electrolytes are almost completely ionised.—E. Rhodes and R. M. Woodman: The fatty substances of the plant growing point. Data are supplied as to the fats present at the growing apices of root and shoot of the broad bean at different stages of growth. These are supplemented by data as to the fats formed in excised root tips kept growing in culture media under sterile conditions.—J. H. Priestley and G. Redington. The effect of diurnal periodicity upon fibre production. Plants have been grown under artificial light, some remaining continuously illuminated, other being removed to a dark chamber for 8 or 16 hours each day. A diurnal periodicity in illumination greatly favours the production of sclerenchyma.—W. T. David, S. G. Richardson, and W. Davies: The effect of infra-red radiation upon combustion of gaseous mixtures containing nitrogen. The rate of combustion of inflammable gaseous mixtures contained in a closed vessel is increased by introducing radiation into the reacting system provided that (1) the radiation is of the type which is absorbed by the combustible gas, and (2) that nitrogen is present in the mixture.

SHEFFIELD

Society of Glass Technology, October 21.—T. C. Moorshead. (Presidential Address) The glass bottle industry and its future developments. The last quarter of a century saw practically a revolution in the manufacture of glass containers. About 1900, two ideas, totally different in principle, suddenly blossomed forth. One was Homer Brooke's idea of feeding a machine with a stream of glass flowing by gravity from the furnace—the other was the application of the suction principle in feeding the machine, a process developed by M. J. Owens. From this

time progress in the development of mechanical devices for glass manufacture has been rapid. To-day many bottle manufacturing plants are mechanically operated practically throughout. In the firm belief in the feasibility of the principle of feeding and melting the batch at the same time, and with the view of blazing the trail for future and more extensive research work, the United Glass Bottle Manufacturers, Limited, are arranging to finance some experimental work based on the principles outlined by Mr. Alex. Ferguson, and described to the Society of Glass Technology in May 1923. The theoretical advantages claimed for the new process are: (1) Smaller radiating surface per ton of furnace melting capacity, the ratio being approximately 2 to 1. (2) More intimate contact between the flame and the constituents of the batch. The first mentioned, however, depends upon (a) the feasibility of melting the batch, when pulverised and fed into the furnace in fine powder, in the short time of passage through the flame; (b) the corrosive effects of the stream of melted glass on the side walls of the funnel-shaped melting chamber, as well as the effect on the glass itself.

PARIS

Academy of Sciences, October 5.—Maurice Hamy: Study of the photography of stars in full daylight.—H. Deslandres: Complementary researches on the structure and distribution of band spectra. Further considerations regarding the formula giving the frequency as a multiple of the universal constant 1062.5.—R. Szilard: A new method of distinguishing culture pearls. The method is based on the difference in the densities of natural and cultivated pearls. The pearls are placed in a tube with methylene iodide, and bromonaphthalene added drop by drop, with shaking. For a certain mixture, some float at different heights, others go to the bottom of the tube: the latter are the culture pearls. This test is not applicable to 'blue' pearls.—R. H. Gernay: The cycles of periodic integrals infinitely near partial differential equations of the first order.—A. Dufour: Michelson's experiment. A correction of an earlier communication.—Mlle. Anastasie Anargyros: Colloidal oxide of manganese. Potassium permanganate, reduced in the presence of sodium protobate, gives stable colloid solutions of manganese dioxide. After purification by prolonged dialysis, the colloid exhibits Brownian motion, is electronegative, and remains unchanged for a month.—Alfred Schoep: Buttgenbachite, a new mineral. This mineral was found adhering to cuprite from the Belgian Congo, and has the composition $18 \text{ CuO} \cdot 3 \text{ Cl} \cdot \text{N}_2\text{O}_5 \cdot 19 \text{ H}_2\text{O}$.—R. Weil: The synthesis of cristobalite in the wet way. Precipitated silica and sodium silicate solution, heated in a steel tube at $650^\circ\text{--}750^\circ \text{C}$. for seven to fifteen hours, gave crystals of quartz and cristobalite.—G. Georgalas and N. Liatsikas: The new eruption of the volcano of Santorin (August 1925). Details of observations made during the eruption, July 28–August 23.—Henry Hubert: The seasonal clouds of the rains in western Africa.—L. Petitjean: The distribution of the forces in the neighbourhood of a discontinuity.—Jacques Pellegrin: The presence in Morocco of *Pelobates caltripes*.—Armand Dehorne: Observations on *Lagis Koreni*: hermaphroditism, paramyelinic formations in the ovule; nephridian cells with capsules containing a central body.—G. Mouriquand and Leulier: Avitaminosis C (with or without tuberculosis) and cholesterol of the blood and suprarenals. It is shown that both chronic and acute avitaminosis C is accompanied by profound changes in the metabolism of the

cholesterol of the suprarenal capsules. The trouble is aggravated when associated with tuberculosis.—A. Gruvel and B. Conseil: Remarks on the biology of *Orcinus alalonga* in the sea near the Antilles.—S. Métalnikov and Rapkine: Phagocytosis and immunity in the blastula and gastrula of sea urchins. The larva of sea urchins, even in the blastula and gastrula stages, possesses a marked immunity against *Bact. tumefaciens* and *Contacuzène's* micro-organism. On the other hand, it is very sensitive to the cholera bacillus. It is shown that the immunity against the first two organisms is due to phagocytes detached from the summit of the primitive intestine.—E. Grynfeldt and H. J. Guibert: The alterative lesions of the lamellar tissue in the course of experimental inflammation.—Léon Binet and René Fabre: The elimination of camphor and oil, after experimental injection of camphorated oil. The camphor is rapidly eliminated, mainly through the kidneys. The oil remains for some weeks at the place of injection, and is slowly absorbed by leucocytic action.

CAPE TOWN.

Royal Society of South Africa, September 30.—James Moir: Colour and chemical constitution. Pt. xxi.: An astronomical orbit theory of colour with special reference to the dicyclic azo dyes. In the monocyclics, colour is built up from one ring by adding a hapton; in the dicyclics colour is built down by bending the chain. The mathematical theory in the paper does not supplant the author's earlier factorial theory, but endeavours to give it a physical basis.—C. Pijper: Note on witchcraft in Europe: the case of Anne Boleyn. The motive for the execution is considered to have been the belief that Anne Boleyn was an adherent of the witch-cult. The author bases his study on the work of M. A. Murray.—Ernest George: (1) The preparation of umbelliferone.—(2) Some phthalein analogues.—T. R. Sim: The Bryophyta of South Africa.

SYDNEY.

Linnean Society of New South Wales, August 26.—E. C. Chisholm: The Comboyne Plateau: its general conformation and flora. In this paper the flora of the Plateau is briefly dealt with from an ecological or economic point of view; and a list is given of the plants collected on the Plateau arranged in botanical sequence.—John R. Eyer: A comparison of the male genitalia of the Palæosetidae with those of other Lepidoptera Homoneura. From a tabulation of the archaic characters of the genitalia, it is shown that the male genitalia of Palæosetids possess certain structures quite similar to those in Prototheoridae and Hepialidae. They retain more archaic characters than these two families and stand intermediate between Prototheoridae and Micropterygidae, the latter family having the greatest number of archaic genitalia characters among the Lepidoptera Homoneura.—Rev. H. M. R. Rupp: Notes on species of *Pterostylis*. Of the forty-three known species of *Pterostylis* the author has obtained thirty-two and has made extensive field notes regarding their character, habit and geographical distribution. One of the finest species, *P. baptista*, was originally found in a peaty swamp near Fivedock and was thought to be rare but has been found to be fairly abundant at Bulladelah.—Prof. M. Bezzi: On the tachinid genus *Euthera*, with descriptions of new species from Australia, Africa and South America. A key is given for the determination of the seven known species of *Euthera*, four of which are described as new.

Official Publications Received.

Department of Scientific and Industrial Research. Report of the Fuel Research Board for the Period ended 31st December 1924, with Report of the Director of Fuel Research Pp vi+78+8 plates (London: H.M. Stationery Office) 1s 6d net.

Annals of the (Middelengien van het) Transvaal Museum Vol. 11, Part 3. The Splendours of South Africa, Part 3, by Dr. George Arnold. Three additional new species of South African Dolichopodidae (Diptera), by C. H. Curran; On Upper Albian Ammonoids from Portuguese East Africa, with an Appendix on Upper Cretaceous Ammonites from Maputo-land, by Dr. L. F. Spath; Cretaceous Gastropoda from Portuguese East Africa, by Leslie R. Cox Pp. 137-230+plates 27-30 (Cambridge: Printed at the University Press).

University College of North Wales Calendar for Sessions 1924-25 and 1925-26 Pp 468 (Bangor).

Empire Cotton Growing Corporation Memorandum by the Mechanical Transport Sub-Committee, G. H. Baillie, R. H. Brackenbury, Col. C. N. French Pp 20+9 plates (London: 3 Wood Street, S.W.1.) 2s.

Scientific Papers of the Institute of Physical and Chemical Research No. 37. Change of Wave-Lengths for certain Lines of Zinc, Cadmium and Mercury in a Condensed Discharge By Nitsuharu Fukuda. Pp 183-192+plates 11-16 65 sen No 38. On the Insecticidal Principle of Insect Powder (Chrysanthemum Cinerarifolium, Booc.) By Ryo Yamamoto Pp 193-222 80 sen No 39. Sur la composition du nickel réduit comme catalyseur Par Bennohke Kubota et Kiyoshi Yoshikawa. Pp. 223-232 20 sen No 40. Use of Grating for the Ether-Drift Experiment By Uzuu Doi Pp 233-241 25 sen (Tokyo: Institute of Physical and Chemical Research, Komagome, Hongo).

Observations de Zi-ke-wei Annales de l'Observatoire astronomique de Zi-ke (Chine). Tome 14, Fascicule 1 Observations du soleil (taches et protuberances), 1920, 1921, 1922. Pp A59 (Chang-hai).

Memiors of the Asiatic Society of Bengal Vol. 9, No. 1. Geographic and Oceanographic Research in Indian Waters By Major R. B. Seymour S.Well. Part I The Geography of the Andaman Sea Basin Pp 20+5 plates 315 rupees Vol. 10, Part 1 Studies in Santal Medicine and connected Folklore By Rev P. O. Bodding Part 1 The Santals and Disease. Pp. vii+182. 5.1 rupees (Calcutta).

Imperial Economic Committee. Report of the Imperial Economic Committee on Marketing and Preparing for Market of Foodstuffs produced in the Overseas Parts of the Empire First Report General. (Cmd 2493) Pp 38 (London: H.M. Stationery Office.) 4d net.

Diary of Societies.

SATURDAY, NOVEMBER 21.

BRITISH MYCOLOGICAL SOCIETY (at University College), at 11 A.M.—S. Dickinson New Method of Isolating Single Spores.—W. J. Dowson Fall of Apples Associated with Core-rot due to *Sclerotinia Frustrigena*.—J. Ramebottom Fragmenta Mycologica IV.—A. Smith. Penicillium Diseases of Gladiolus and Narcissus.—A. Lorrain Smith Lichen Dyes.—E. M. Wakefield and W. Buddin: Life-history of a Fungus Parasitic on *Antirrhinum Majus*.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (jointly with Institute of Mining and Mechanical Engineers) (at Neville Hall, Newcastle-upon-Tyne), at 3.—R. Dowson: The Steam Turbine in the Electrical Industry.

MONDAY, NOVEMBER 23

NORTH STAFFORDSHIRE INSTITUTE OF MINING ENGINEERS (Annual Meeting) (at Central School of Science and Technology, Stoke-on-Trent), at 8.—Presidential Address.

INSTITUTE OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. E. Tasker and others Discussion on The Testing of Large Electric Plant.

INSTITUTE OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—T. Carter The Engineer his Due and his Duty (Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Dr R. Lessing Coal Ash and Clean Coal. I. (Cantor Lecture.)

ROYAL GEOGRAPHICAL SOCIETY (at Eolian Hall), at 8.30.—Dr. H. Gordon Thompson From Yunnan-Fu to Peking along the Tibetan and Mongolian Borders.

CHEMICAL INDUSTRY CLUB

TUESDAY, NOVEMBER 24.

ROYAL DUBLIN SOCIETY, at 4.15.—K. G. Bailey The Action of Radon on Mixtures containing Ammonia and an Oxide of Carbon.—P. A. Murphy and R. McKay Methods for Investigating the Vicious Diseases of the Potato, and some Results Obtained by their Use.—E. J. Sheehy An Examination of the Errors Introduced by the Various Approximate Methods used for Estimating the Total Quantities of Milk and Butter Fat Produced during a Lactation.

INSTITUTE OF AUTOMOBILE ENGINEERS (at 88 Pall Mall), at 6.30.—Discussion on Gradient Meters and Tire Pumps.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—O. Brunler Internal Combustion Boilers.

INSTITUTE OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—F. Carter The Engineer his Due and his Duty (Lecture).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt. J. Noel: The Story of the Mount Everest Film and Slides.

ROYAL ANTHROPOLOGICAL INSTITUTE (at Royal Society), at 8.30.—Sir Arthur Evans: Early Nilotie, Libyan, and Egyptian Relations with Minoan Crete (Hurley Memorial Lecture).

WEDNESDAY, NOVEMBER 25.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Neville Hall, Newcastle-upon-Tyne), at 7.15.—C. H. Cooke Lubrication.

INSTITUTE OF AUTOMOBILE ENGINEERS (North of England Centre) (at Houldsworth Hall, Dewsbury, Manchester), at 7.15.—Capt. R. K. Hubbard The Requirements of the Military Motor Vehicle.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section) (at University College, Nottingham), at 7.15.—A. T. King Migration of Alkali (in Wool), or Indicator-dyed Wool.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.30.

ROYAL SOCIETY OF ARTS, at 8.—D. Greenhill Colour Printing.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at 1 Wimpole Street), at 8.30.—Dr. E. Glover The Neurotic Character.

THURSDAY, NOVEMBER 26.

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street), at 5.30.—A. H. R. Fadden Installation Problems in Air-cooled Engines.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. L. J. Llewellyn Diathesis (Presidential Address).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Brig.-Gen. R. J. Keutish Playing-Fields for Children.

INSTITUTE OF STRUCTURAL ENGINEERS (Yorkshire Branch) (at Great Northern Hotel, Leeds), at 6.30.—E. C. Snelgrove Fieldwork in Central Africa.

INSTITUTE OF AUTOMOBILE ENGINEERS (Luton Graduates' Meeting) (at Luton), at 7.30.—W. B. Flint The Motor Omnibus as a Means of Public Transport.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry, Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 7.30.—J. W. Mitchell Fuel.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Neville Hall, Newcastle-upon-Tyne), at 7.30.—G. S. Baker: Measured Mile Trials and other Ship Propulsion Data. Part II.

CHEMICAL SOCIETY, at 8.—Prof. R. Robinson Recent Researches on the Structural Relationships of some Plant Products (Informal Lecture).

INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (London), at 8.—Impromptu Debate.

FRIDAY, NOVEMBER 27

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section, jointly with International Society of Medical Hydrology), at 10 A.M.—Discussion on The Treatment of Rheumatism in Industry.

INSTITUTE OF AUTOMOBILE ENGINEERS (at Olympia), at 11 A.M.—O. H. Macmillan The Installation of Small Marine Motors.—At 2.30.—Basil H. Joy The Advantages of Twin-Screw Installation for Motor Boats.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—R. G. Linnon Atomic Dimensions.—W. E. Benton On Edge Tones.—J. J. Manley The Spectroscopic Determination of Minute Quantities of Mercury.—Demonstration by G. R. Mather of an Instrument for Imitating the Eastward Motion of Bodies Dropped from a Great Height.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with Institute of Chemistry) (at 29 Elmbank Crescent, Glasgow), at 7.—W. G. Hiscock The Heat Evolved during the Detonation of Explosives.

INSTITUTE OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—A. P. Hill The Tungar Rectifier.

JUNIOR INSTITUTION OF ENGINEERS, at 7.—E. Granville-Smith The Engineer and his Relationship to the Traction Industry.

INSTITUTE OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—W. P. F. Fanghanel and others Discussion on The Work of the Mechanical Engineer in Non-Engineering Industries.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section) (at Middlesbrough), at 7.30.—W. L. Rigby Steel Framed Structures.

SATURDAY, NOVEMBER 28.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—S. L. Pepper Mining Royalties, with Special Reference to Surveying.—Papers open for further discussion.—Underground Efficiency in Collieries, with Special Relation to Labour, by H. R. Houston; Modernisation of Old Collieries, by H. P. Mould.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 21

HORNIMAN MUSEUM (Forest Hill), at 3.30.—G. O. Robson Animal Life in the Depths of the Sea.

TUESDAY, NOVEMBER 24

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakley: The Philosophy of Aristotle: The Highest Good for Man: The Best and Actual States.

WEDNESDAY, NOVEMBER 25

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. W. M. Willoughby Infection in Ships and the Prevention of spread therefrom.

CHEMICAL SOCIETY, at 5.30.—Dr. E. A. Koen The Physicist in Agriculture, with Special Reference to Soil Problems (Lecture in the series "Physics in Industry," given under the auspices of the Institute of Physics).

UNIVERSITY COLLEGE, at 5.30.—G. F. Barwick The British Museum for Research Purposes.

THURSDAY, NOVEMBER 26

KING'S COLLEGE, at 5.15.—E. L. Woodward Thomas Hobbes.—At 5.30.—M. Bera The Story of the Creation and the Flood in Roumanian Folklore (Succeeding Lecture on December 3.)

SATURDAY, NOVEMBER 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovell The Luck of an Old Shoe.



SATURDAY, NOVEMBER 28, 1925.

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Research in Mental Disorder.

WE welcome the address of the Earl of Birkenhead at the Royal Society of Medicine lately as evidence that it is at last appreciated by others, besides a very few specialists, that far graver and more urgent criticisms may be launched against the present lunacy administration than have yet reached public notice. So long as fault-finding was based solely on allegations of abuse of official power, entailing injustice or ill-treatment of individuals, it was clear to most people who had any understanding of the facts that agitation might be futile or mischievous, but it could do nothing to advance our methods of dealing with the vast problem of mental unfitness, either medically or socially.

Lord Birkenhead displayed a caution and moderation proper to a lay approach to a highly specialist problem when he "doubted whether medical science, medical care and nursing efficiency had made the advance in dealing, from the preventive point of view, with mental cases, that, even in his lifetime, they had made in almost every branch of medical and nursing science." So far as medical science is concerned, a unique combination of disastrous circumstances has conspired to restrain advance. More than 7,000,000¹ is expended annually upon the upkeep of mental hospitals in England and Wales alone, and this sum, large as it is, gives but a partial and uncertain indication of the economic importance of mental disorder, taking no account of the cost to society, from inefficiency, mistakes and crimes, of a multitude of sufferers, uncertified or uncertifiable, the existence of which has only recently been revealed through the establishment of a very few widely scattered out-patient clinics. Nor does it count the cost of congenital mental deficiency in most of its forms and degrees. It is merely one item in an account the true magnitude of which cannot be gauged. From the humane point of view, also, mental disorder deserves at least as much consideration as other disorders. Lunacy as a disease is not painless in any but the narrowest sense.

Lord Birkenhead spoke only a day or two after the publication of specialist opinions which deserve as wide attention as his. They were Dr. Bernard Hart's, that the actual state of affairs with regard to research and the early treatment of mental disorder were in Great Britain "little short of a scandal," and Dr. Mapother's, that "whether strictly between ourselves we may not admit that we have no definite information on the prevention of mental disorder."²

The phraseology of these criticisms would be mild if mental disorder were something new which had come

¹ 7,658,823 in 1922. The figure, 6,933,804, given in the Report of the Board of Control for 1924 is for County and Borough Mental Hospitals only.

² *Brit Med Jour*, Oct. 31, 1925.

upon our community suddenly. Its main features have been well known throughout historic times, and it is well over a hundred years since Gall laid the foundations of an extensive science of cerebral structure and function. Physiology has attained dimensions which would appear vast even to Huxley. Medicine, preventive and curative, has its victories. But of psychology and mental disease, nothing: even to say that they had baffled us would be dishonest, for that would imply a vigour of attack which is wholly lacking.

The responsibility for this remarkable situation may lie with the medical men who undertake the study of mental disease and the care of the insane; with the authorities, for the most part public, which employ them; or with the Board of Control which at present supervises the administration of the Lunacy Act. A discerning reading of the Board's recent reports, and particularly that just published,³ throws some light on this point, surely a vital one for future development. They certainly betray a confusion of mind which cannot fail to be reflected in asylum committees and through them in the administration of mental hospitals. It was not until 1922 that the Board's attention was diverted, probably with relief from pressing domestic matters, to the problem of research. It then found that "it has long been realised that there is an urgent necessity for co-ordinated research into the basal causes of mental disorder."

Trite remarks of this kind are inevitable from a body the natural course of which, if not a "neat rivulet of text in a meadow of margin," is a broader and correspondingly a shallower flood, for, so far as public asylums are concerned, the Board has no executive authority worth mentioning. In private institutions it can, and frequently does, indulge any fancy of the reforming zeal on pain of immediate closure; but elsewhere it can only hope without expectation and desire without hope. In consequence, the Reports of the Board are politely benevolent in tone, with a strong flavour of reminiscence and remoteness. These tendencies are clearly evident in the matter of research. What attracted the sudden interest of the Board was the inception of a scheme at Birmingham for research under the City and University jointly. The means were provided by private generosity. This appeared to be fortunate to the Board, which recalled the fact that in the absence of legislative permission local authorities "are precluded from collaborating with this object."⁴ No wonder that "it is our hope, and we shall do all in our power towards its fulfilment, that

similar or corresponding Research Centres will be instituted in connexion with each University." Three years later this hope has expanded slightly and we find (p. 106)—"We wish, too, to repeat our desire (see 9th Report, p. 55, and our last Report, p. 70) to see research centres (Schools of Psychiatry) established—one in connexion with each of the Universities—with each of which all the institutions at which mental cases are received in the neighbouring counties would be grouped and affiliated."

It may be argued that, while a Royal Commission is inquiring into the present administration, the Board of Control does wisely to mark time. But this phrase is not one which properly describes the Board's activities. They are directed towards a definite policy—the grouping of mental hospitals about central laboratories with a more or less ill-defined university association. This plan, at present in operation, is inadequate to the real need. But "it is with no small satisfaction" that the Board observes a tendency to develop along these lines. Then it plunges into an argument which reveals at once the hopeless confusion into which a problem may be thrown by special pleading in conjunction with irresponsibility. "Not less than 60 per cent of the [mental] hospitals possess a laboratory *in more or less active operation*, in 21 of which the work is *to some extent* linked with a teaching centre." (Eight universities and the Maudsley Hospital are named.) The position "though there is room for a good deal of improvement, . . . compares favourably with that which obtains outside mental hospitals, where, we gather from information kindly supplied from 8 general hospitals *exclusive of those which subserve a Medical School*, the proportion at which laboratory work is prosecuted is 46 per cent." Without information concerning the size and character of these hospitals comparison is impossible. Ninety-six mental hospitals average 1082 patients each. How many points of view are the following passages, found cheek by jowl in the same paragraph (p. 181), designed to meet?—

I. Sound training and skill in ordinary bedside examination are essential, and it would be a great mistake were it to be neglected or undue reliance placed upon laboratory reports. Nevertheless, a growing recognition of the important part played by certain bodily conditions—*e.g.* morbid states of the nose, throat, teeth, intestines, blood and other fluids—endocrine disturbance, the presence of the syphilitic virus, etc. . . . makes it imperative that every mental hospital should possess at least a small clinic laboratory, instead of relying on the present inadequate method of posting a selection of specimens for examination elsewhere. . . . *It is a waste of time for much of this work to be actually performed by a doctor*, and the medical staff should not be expected or encouraged to undertake it, the employment of a trained labor

³ The 11th Annual Report of the Board of Control, 1924 (London: H.M. Stationery Office, 1925) 12s 6d net.

⁴ In the case of London with its many hospitals this difficulty has not arisen. So long ago as 1895, Sir Frederick Mott was appointed by the L.C.C. to control a joint pathological laboratory at Claybury.

tory Assistant, who will work under their instructions, is therefore not only desirable but essential.

II. As to the medical staff, while it is an advantage if all can find time for at least some work or attendance in the laboratory, *the routine application of laboratory investigation in aid of bedside methods is likely to be more reliable and systematic if entrusted either to a resident or to a visiting pathologist*, the latter alternative being the manner in which the smaller hospitals probably can best meet these requirements. Even where there is a resident pathologist, however, unless he is allowed to undertake duties at a general hospital . . . it seems to us desirable that a pathologist should be appointed on the staff of Visiting Specialists. When the mental hospital is in the vicinity of a University, it would be an additional advantage were he a member of the University staff.

Surely the Board is aware of the difference between a laboratory assistant and a pathologist of university rank.

It has been the custom of the Board recently to publish an account of asylum laboratory work compiled from statements made to the Board by medical officers. This is headed in the present report "Scientific Research Work in Mental Hospitals in 1924." The returns are seventeen in all. They are not constructed upon any general plan, and to the uninitiated the information they contain is not presented in an easily assimilable form. Throughout, there is no effort to distinguish between the barest necessities of clinical investigation and research; between research into what may be termed "administrative" diseases—physical disorders affecting the administration of asylums, like dysentery—and research into mental disease; between research into treatment and research into "the basal causes of mental disorder." The reports which mean most are generally the shortest and convey least information; those which mean nothing are most painfully detailed—urines tested and throat swabs taken, with actual figures but no percentages of hospital population. All this is collected together, with serious work at Cardiff, in the north of England and at the Maudsley Hospital, to fill forty-one closely printed pages of "scientific research."

On other vital points, the Board is an adroit but scarcely a trustworthy guide.

"In our view, doctors who take up permanent resident posts in mental hospitals can fairly be expected to acquire a specialist's competency in psychological medicine; but it is unfair to them and to their patients to expect them, for instance, to undertake surgical operations or to possess a corresponding competency in other branches, which is nevertheless wanted for a proper elucidation of many cases." At some hospitals "it happens that one or more of the resident medical staff has special competency in some of these branches, and reliance is placed on his services; however great his competency, we think this policy is a mistake, as it

. . . must . . . cause the sacrifice of time which can ill be spared from his recognised duties."

If his recognised duties are partly administrative—and without actual experience few can realise how heavy this may be—and partly the care of a number of patients varying from 300 to 600. It is scarcely surprising that research reports are under suspicion.

What interest does it serve to disguise the facts of mental research or to present them in a garbled and unintelligible form? If there is no time for serious research, no facility, no guidance, why should not public authorities be told that they have made no provision for more than the detention and care of their insane patients? London, with 182,068 certified insane, has one qualified pathologist to whom are referred most of the more refined diagnostic questions of many hospitals and the intensive physiological investigation of the Maudsley patients. If all that is contemplated in that extraordinary paragraph quoted above about laboratory tests were referred to him, he would be utterly unable to deal with it. Similarly with the Birmingham laboratory. Last year this laboratory summarised its work as follows:

TOTAL SPECIMENS.

Total Bacteriological	1306
Total Wass, Sig., Colloidal gold	459
Total Serolog Agglutinations	375
Total Chemical Sundry	175
Total Basal Metabolic Determinations	60
Total Iodine in Thyroid Glands	60

Most of this is not research work but routine work, undertaken to persuade a parsimonious and pound-foolish public to allow the research worker to approach his subject in his spare moments.

It is by disguises and evasions of this kind that a situation has grown up which richly deserves the strictures of Dr. Bernard Hart and Dr. Mapother. The men upon whom falls the direct responsibility are the worst paid in the medical profession. They are in most cases on duty for ninety-five hours a week in circumstances which rigidly restrain enterprise and enthusiasm; and in addition they must struggle to adjust themselves to the atmosphere created by official short-sightedness. The prevailing affective tone is one of cynicism and discontent. Would it not be a simple expedient for the Government to appoint a single Commissioner to report upon the scientific aspects of mental disorder? It is one which, directly or indirectly, has been richly productive in other scientific questions of great public importance, and it need not conflict with the work of the present Royal Commission. But preferably he should be a man of science independent of the conflicting interests of the asylum world.

Recent German Work on Heredity and Evolution.

Die Abstammungslehre: Tatsachen, Theorien, Einwände und Folgerungen im kurzer Darstellung. Von Prof. Dr. Ludwig Plate. Zweite Auflage des "Leitfadens der Deszendenztheorie." Pp. vii + 172. (Jena: Gustav Fischer, 1925) 6 gold marks.

Pluripotenzerscheinungen: Synthetische Beiträge zur Vererbungs- und Abstammungslehre. Von Valentin Haecker. Pp. viii + 213. (Jena: Gustav Fischer, 1925.) 9 gold marks.

THESE two books contain some of the most recent German ideas on the subject of heredity and its bearing on theories of evolution.

(1) Prof. Plate's work is an ordinary treatise on evolution, embodying all the well-known arguments from embryology, morphology, and palæontology, and evidently intended more for the benefit of the intelligent outsider than for the special student of biology. It is beautifully illustrated, and on this account possesses a value of its own, whether we do or do not agree with Prof. Plate's conclusions; we may mention two views of an almost perfect Moustarian skull from the Berlin Museum on page 137; views of the male and female Bird of Paradise on page 31; views of the male of *Papilio memnon* of the three types of females belonging to this species on page 32.

When we come to the theoretical part of the treatise, we find that Prof. Plate, like St. Paul, endeavours to be all things to all men. He accepts "mutations" as the causes of evolution, and also reactions to changes of condition—which is essentially Lamarckism. He admits that the attempt to produce changes in animals which shall be inheritable has met with a considerable measure of success: he accepts as valid the results of experiments of exposing the pupæ of Lepidoptera to changes of temperature: these experiments produce changes of coloration not only in the imagines which emerge from the pupæ but also in the following generation. It seems to us, however, that Prof. Plate, like so many modern zoologists, thoroughly misunderstands Lamarck when he opposes natural selection, and the inheritance of acquired qualities, and when he rejects what he calls Lamarck's assumption of "psychic roots" for variation in Lamarck's phrase "the inner needs." Whether we accept Lamarckian ideas or not, there is no escape from natural selection. The logic that since the female cod produces nine million eggs a year, and that since on the average only two of her progeny reach maturity, all the rest must prematurely perish, is unanswerable. But the slaughter of the majority of the family does not in itself explain the qualities of those that survive.

In order that any change may be produced at all, there must be constant variation, and to find the causes of this is the real problem of the evolutionist. The great attractiveness of the Lamarckian doctrine is that it proposes an explanation of these variations; and therein it gets nearer to the root of the matter than Darwinism. Lamarck's assumption of "inner needs," by which he means the appetite or urge that spurs an animal to activity, is a piece of the most far-sighted philosophy. Modern research on animal behaviour—such as that of Jennings on the most primitive animal of all, *Amoeba*—has shown that it is utterly impossible to explain the activities of even the lowest form as a mechanically connected chain of automatic reflexes. All animal life is a striving to attain ends, and this striving is expressed in the activities of the animal, in a word, in its habits, and changes in habits lead to the use and disuse of organs.

Prof. Plate states that neither the Lamarckist nor the selectionist has been able to produce a crucial experiment in support of his views. We may predict that no Lamarckist will ever be able to adduce a proof which will satisfy his opponents so long as their minds are obsessed by the Weismannian complex. For of any account of experiments, however conclusive, they may say that they will not accept them but will wait until these have been repeated, and as such experiments require periods of from five to fifteen years for their accomplishment, and the objectors make no effort to repeat them, their entrenchments will be impregnable. Only as younger and more plastic minds succeed to those trained in the older philosophy will Lamarckism come to have justice done to it.

Prof. Plate concludes with a chapter on the relation of the doctrine of evolution to religion and education which throws an interesting light on post-War German psychology. He attacks in the most vigorous language "Haeckelismus," which we may translate as the "mechanist" view of life: he asserts that a monistic view of Nature with our present knowledge is impossible, and that matter, force, and spirit are incommensurables, which the theory of evolution does not aid us in connecting with one another. The efforts of Haeckel to alienate the people from the Church is deplored; since only on the central doctrines of the Church can a practical system of ethics be founded.

Prof. Plate then goes on to make an equally violent attack on what he terms the "Jewish" doctrines of democracy, universal peace, and the equality of the races of men. The fact that all life is the history of a struggle is emphasised, and the German youth is warned to beware of being deprived of the powers of self-defence through being misled by these ideas.

(2) The treatise on "Pluripotenz" by Dr. Haecker

is a book of quite a different character. It is an attempt to penetrate further into the causes of variation, by bringing together a large number of obscure phenomena. It is in our opinion a rather confused book, but it is a valuable testimony to the fact that thoughtful German opinion is beginning to be discontented with the fashionable theory of variation embodied in the terms "factors" and "genes." By "Pluripotenz" is meant the fact that the form which an animal or vegetable germ develops does not fully express its latent powers, that in other circumstances it can produce something quite different; so, for example, the skin in the shoulder-region of the tadpole normally produces only skin, but if the embryonic eye-vesicle be cut off from the brain and pushed along under this region, then the skin of the shoulder will develop into a lens. But in later chapters the conception of "Pluripotenz" is enlarged to include the fact that quite similar variations turn up independently in different strains of the same larger group; so, for example, the transformation of the molluscan mantle-chamber into a lung has occurred at least six times. "Petaloidy," or the transformation of stamens and carpels into petals, occurs independently in quite unrelated flowers. A blue colour crops up in the plumage of birds belonging to quite different families. A further application of the idea of "Pluripotenz" is to the effect of the sex-hormones on the growing bodies of many forms of animals, so that, as Zawadowsky has shown, it is possible to convert a hen into a cock with comb, spurs, hackles, tail feathers, and voice complete by first extirpating the ovary and then grafting on a testis. Then "Pluripotenz" is also stretched to cover cases where several so-called "mutations" occur, in some cases associated with one another and in other cases separately. So in human families "polydactyly," or supernumerary fingers, and "syndactyly," or a web of skin between the fingers, and "brachydactyly," or the fusion of two of the phalangeal bones in each finger, associated with a short thick shape, often occur together, but one of these characters may appear and be inherited specially.

Having thus stretched "Pluripotenz" like an overcoat which covers many defects, over a whole range of vaguely defined phenomena, Dr. Haecker endeavours to extract from these phenomena certain general ideas. He points out that if a large group of divergent genera, or even families, are descended from a single ancestor, they will have inherited from this ancestor a particular type of germinal substance, which in consequence will be specially liable to the same type of change in all the descendants of that ancestor. This is, in fact, "orthogenesis" in the sense in which Eimer used the word, though so-called orthogeneticists nowadays employ it in a very different sense. Dr. Haecker gives

a beautiful analysis of the causes of the blue colour in birds' feathers. The formation of yellow and brown pigment in the cortical cells is inhibited and the superficial cells of the medulla become hollow boxes the walls of which are pierced by pores. These pores exist in this situation in all feathers, but in these blue feathers they are enlarged. The deeper cells of the medulla develop dense black pigment, so that no light is reflected from them, and the light reflected or rather scattered from the "cloudy medium" constituted by the horn + air of the superficial cells of the medulla is blue.

When dealing with the various associated mutations in man and other mammals, Dr. Haecker puts forward the valuable idea of a definite "habitus" which manifests itself in more or fewer symptoms according to its intensity. We may translate "habitus" by "diathesis," and Dr. Haecker directs attention to the fact that all these symptoms are indications of "Entwicklungshemmung," which we may translate as "germ-weakness." Thus, polydactyly is often associated with hare-lip and mental defect. Even brachydactyly, which superficially regarded appears to be an insignificant aberration, is fatal when inherited from both sides of the house, for brachydactylous people when they marry with each other are childless.

Lastly, Dr. Haecker attacks the crude conception of the linear arrangement of the genes in the chromosome, and the idea of crossing over. He points out that Chambers has shown by micro-dissection of living cells that the chromosome in life is an elastic gelatinous rod, and the absurdity of supposing that such a rod would break in the complicated manner which Morgan assumes is obvious. He discounts all deductions from stained figures of chromosomes in which a pair appear to be spirally twisted around one another, stating that exactly the same figures can be seen in the vegetative division of nuclei in *Radiolaria*. Finally, he makes the significant remark that only in *Drosophila* has a correspondence between chromosomes and linkage-groups of genes been observed: the significance of this would have been still more evident had he been aware that in the pea, nine linkage groups have been demonstrated, and there only exist seven chromosomes.

It appears to us that in recent times nothing more disastrous to the real progress of biology has occurred than the spread of the idea of "genes" and crossing over; for it has induced many biologists to be content with pseudo-explanations, which consist in inventing new imaginary entities to fit all irregularities which turn up, and it has diverted research from seeking the real physiological bases of these mutations. Each particular group of animals, of course, requires special investigation, but Jansen in Holland, Törnier in Germany, and Sir Robert Jones in Great Britain have

shown that a whole host of mutations (many of which are "linked") which occur in man can be regarded as results of one cause, namely, amniotic pressure. Their linkage is not due to the ranging of genes in a chromosome, but they are manifold results of the same weakness. The embryo of the higher vertebrates is early covered by the amniotic fold: this at first clings closely to the embryo, but as growth proceeds it is forced away from it by the secretion of the amniotic fluid, and into this fluid the various members grow out. The secretion of this fluid is correlated with rocking movements of the embryo, as Foster and Balfour showed forty years ago. If then, owing to germ weakness, these movements are weakened, too little fluid is secreted and the amnion for a longer or shorter period clings too tightly and presses on growing members and inhibits their growth. "Polydactyly" and "brachydactyly" are both due to the pressure of the amnion on the growing rudiments of the fingers. In the first case the rudiment is split into two, and in the second case it is shortened. When the amniotic pressure sets in early it may interfere with the growth of the brain and produce mental defect, and in extreme cases it may inhibit the growth of the brain altogether and so prove to be what Morgan calls a "lethal factor." The childlessness of brachydactylous couples seems to be due to the lethal effect of a double dose of germ weakness.

We do not for a moment suggest that all manifestations of "Pluripotenz" are associations of symptoms due to a given grade of germ-weakness. The fact is that Dr. Haecker has grouped together things of totally different nature. The development of a lens, for example, from the skin of the shoulder in a tadpole means that all the nuclei of the embryo are potentially alike as their chromosome content shows, and in all the complete hereditary powers of the organism are latent; and it depends on the stimulus applied which of these powers are manifested. So in fowls, the male and female sex hormones are capable of producing on indifferent material (the ordinary cells of the body) quite different results.

Similar organs turning up independently as specific characters in quite different stocks of the same class are the reactions of similar constitutions to similar changes in the environment; so the independent production of a lung in different groups of the Gastropoda may be explained. Sometimes the similarity may be due to the atavistic reproduction of a long-lost organ which may be compared to the revival of an almost forgotten memory. Of this a marvellous example was recently given to the Zoological Society by Mr. Tate Regan, and with this we shall close. It is as certain as anything of the kind can be that the original dermal skeleton of fish consisted of scales like those now found in our

sharks and rays. Remnants of this "shagreen" exist in all the higher vertebrates in the form of teeth; for the scale of the elasmobranch fish is merely a dermal tooth. As time went on the bases of these dermal teeth became bound together by calcifications of the dermis beneath them; and thus bony scales came into existence which soon rendered the teeth superfluous, although in the bony gar-pike of N. America (*Lepidosteus*) microscopic representatives of these teeth can be found scattered around the periphery of the scales. When the first Teleostei appeared, which may be termed Jurassic herring, even these remnants had disappeared and the scales alone were left. Later, probably in Eocene times, the first invasion of the rivers by Teleostei took place, and thus were evolved the oldest teleostean fresh-water fish, the Characini of Africa and South America. These Characini are covered with smooth well-developed scales. In turn these gave rise to the cat-fish, most of which have naked skins, but some of their South American representatives have bony scutes, in the intervals between which typical dermal teeth are found exactly like those of an elasmobranch. No more wonderful recovery of long-lost organs is to be found in the animal kingdom.

E. W. MACBRIDE.

The Theory of Limits.

Elements of the Mathematical Theory of Limits. By Dr. J. G. Leathem. Pp. viii+288. (London: G. Bell and Sons, Ltd., 1925.) 14s. net.

PARTLY due to the fact that their knowledge of the subject is acquired piecemeal, most mathematical students show confusion of thought on questions relating to the theory of limits. On it rests the theory of the calculus, the subject above all others where accuracy of thought is needed in the training of a present-day mathematical specialist. For many years Dr. Leathem was known in Cambridge as one of the most genial exponents of the theory of limits: he introduced the arrow symbol for tendency to a limit in 1905. The MS. of the book before us was substantially complete before his death in March 1923. Profs. H. F. Baker and E. T. Whittaker have seen to its publication.

The volume develops the theory of limits in elementary mathematical analysis with lucidity and accuracy. Infinitesimals and infinities, and their orders, are adequately discussed, also elementary asymptotic expansions and the meaning of continuous functions and differentiation. The last section deals with infinite series and products, including the simpler tests for their convergence.

Dr. Leathem only assumes elementary mathematical knowledge on the part of his readers, but, as an intro-

duction to elementary calculus, the book is much too long and elaborate. Some readers (with analytical minds) will revel in the wealth of meaning assigned to the conceptions of infinity and continuity: others will think that all the salient features could have been presented more briefly. It is disappointing to find that so large a volume contains no reference to uniform convergence or to Riemann integration, which are now considered to be essential to the training of a young mathematical analyst. Only three pages are given to the integral calculus, but seven to the less-studied convergence of continued fractions.

The author's proof of the existence of a limit of a sequence of real numbers (when convergent) is made to depend on the one-one representation of real numbers by points on a straight line. Here he protects himself by a footnote saying that the existence of the limit is really postulated by the existence of the arithmetical continuum. It is practically impossible to say what is actually proved in the existence-theorems of Chap. xxii. The defence of Dr. Leathem's book is that it is for beginners, who must have the subject presented much as it would be in the seventeenth century.

Many able teachers of mathematics agree with the late Prof. F. Klein in advocating the use of intuitive methods before strictly logical ones, but it should never be suggested that the latter are unnecessary. From the strictly arithmetical point of view, a logical discussion of irrational numbers, such as Dedekind's or Cantor's, must necessarily precede any criterion for the convergence of a sequence of real numbers. Dr. Leathem's attitude on the matter is contained in his closing words.

"While we have dealt with the conceptions of limits and irrational numbers from the geometrical point of view, regarding it as incomparably the more useful way of presenting the subject to beginners, there is nevertheless the alternative arithmetical aspect, to be studied perhaps at a later stage. As regards these alternatives, the most ardent partisan of either can scarcely claim that a choice between them is a choice between right and wrong; one may doubt if it is a choice between better and worse. As there are mathematicians who find the keenest intellectual pleasure in geometry, so there are others who would approach all subjects, geometry included, by arithmetical methods. The difference is one of temperament and taste, such as cannot be finally disposed of by argument."

This, however, is not the only possible view on the question at stake. Another quite defensible attitude is to say that a choice between the arithmetical and geometrical arguments is not a matter of disposition at all. Every one uses geometry as far as it will go, but geometry is bound to break down due to passing beyond the threshold (*Schwelle*) of intuition; and then the geometry itself must be buttressed by Dedekind's axiom.

W. E. H. B.

The Destructive Distillation of Wood.

The Technology of Wood Distillation: with Special Reference to the Methods of obtaining the Intermediate and Finished Products from the Primary Distillate. By M. Klar. Translated by Dr. Alexander Rule. With an additional Chapter by the Translator. Pp. xv + 496. (London: Chapman and Hall, Ltd., 1925.) 25s. net.

THE destructive distillation of wood is one of the earliest industries known to man. The need of charcoal for fuel and for the smelting of iron was the primary aim of the undertaking. Up to the beginning of the nineteenth century, the carbonisation of wood was carried on mainly with the object of furnishing sources of heat and light. At a somewhat later period the industry was in a precarious condition, for coke and tar from coal distillation successfully competed with the related products from wood.

With the rise of the organic chemical industry in the nineteenth century and the great demand for such products as acetic acid, methyl alcohol and acetone, the wood distillation process survived, but only, as M. Klar remarks, as a result of never-ceasing progress made by chemical research. With the gradually increasing difficulty in obtaining wood supplies, and with competition on every side, the struggle for its existence as an industry was a keen one. It was only by the fullest application of scientific methods, especially in the direction of improving the process of carbonisation and in the manner of working up the volatile products, that success was obtained. The striking features of a wood-distillation plant at the beginning of the twentieth century have been briefly described by M. Klar to include among other operations and processes the following: The use of large carbonising plant with mechanical charging and discharging apparatus; the use of producer gas for heating and the utilisation of waste heat for initial drying of the wood; preheating of the non-condensable gas on the regenerative principle before combustion; scrubbing the gas produced and using it for generating power; economic recovery of calcium acetate and its drying by a continuous process; preparation of pyroligneous acid free from tar, and the rectification of crude wood naphtha and production of pure methyl alcohol in one operation. M. Klar has dealt with all these subjects, and has done his work so well that the original has long been regarded as the German standard in this subject. There is no doubt that this translation will secure a similar position in English-speaking countries.

During the War period, according to M. Klar, the method of operation as carried out in Germany did not undergo such changes as to render a revision of

the book essential, and the third German edition (1920) is a simple reprint of the second (1909) edition with cost data and values of products at the 1909 period left unchanged. Dr. Rule has in the main translated without alteration, but some additional matter and new references have been added. The extra material deals especially with investigations which aim at increasing the yields of acetic acid and methyl alcohol. In many ways the translation has produced a book which excels the original, and Dr. Rule has made every effort to bring the material at his disposal up-to-date. He has certainly achieved his object in filling a gap in the literature of the subject available to English readers. Except for the excellent book by Bunbury, this branch of technology has not received close attention from English writers.

While the state of the industry was insecure twenty-five years ago, the present position is considerably more serious, especially in Europe. Much more valuable uses are now being found for surplus wood than mere destructive distillation. The securing of wood for the production of cellulose for paper and artificial silk, to mention but two requirements, makes an enormous demand on the gradually decreasing forest supplies. But the troubles of the wood carboniser do not end here. Recent progress in applied chemistry has shown that with the aid of electrical power, synthetic acetic acid can be produced in enormous quantities at a comparatively cheap rate. Again, the economic production of methyl alcohol from water gas is now claimed as a commercial proposition in Germany. The wasteful destruction of wood to give small yields of methyl alcohol or acetic acid may therefore before long be unnecessary. Modern practice inclines rather towards the utilisation of the cellulose molecule in the form in which Nature has carefully built it up rather than the wasteful breaking down of this complex to simpler substances. On the other hand, the chemist aims at the direct syntheses of substances such as acetic acid, methyl alcohol, acetone and formaldehyde, and in recent years much success has followed from such efforts. The main hope of the wood distiller in the future possibly lies in the direction of gas production from wood waste unsuitable for other purposes.

Apart from the actual distillation process, there is a considerable amount of very valuable information in this book which will be of great value to the technologist and analytical chemist. Such subjects as charcoal and its composition, wood naphtha, acetate of lime, acetone, acetic acid, formaldehyde, etc., receive detailed treatment. In addition, there is a first-rate analytical section comprising nearly one-fifth of the book, which will be of general use to the chemist in the works laboratory.

J. REILLY.

Our Bookshelf.

Memoirs of the Geological Survey of Great Britain. Palæontology. Vol. 2, Part V.: *Fossil Plants of the Carboniferous Rocks of Great Britain*. By Dr. Robert Kidston. Pp. 377-522 + plates 92-122. (Southampton: Ordnance Survey Office; London: Edward Stanford, Ltd., 1924.) 20s. net.

THE work on which the late Dr. Kidston was engaged at the time of his death is probably the most important contribution to our knowledge of the plants of the British Carboniferous rocks which has yet been printed. Whether regarded as a study of the distribution of species in our British coal seams, or as a critical systematic account of a fossil flora of scientific interest and economic importance, it ranks as a unique work. Unfortunately Kidston's sudden death occurred when only four parts had been published, and the present part is the first to appear since; but it is hoped that several more parts are in a condition sufficiently advanced to admit of their publication. It will be a catastrophe if the material collected for so many years by such an indefatigable worker is not made available by publication.

The present part, like those which have preceded it, deals with those varied and often perplexing fern-like plants which form such an important element in the Carboniferous flora. Some of the genera described and figured are rare and little-known forms, such as species of *Cyclothea*, *Unatheca*, *Anemites*, and *Alcicornopteris*, while others are common but polymorphic forms such as *Dactylothea*. The treatment of the fronds of the fern genus *Pecopteris* is commenced. The old group was a very large and artificial one, and a system of nomenclature is now proposed which will limit the artificial genus *Pecopteris* to a much smaller number of forms. The species which have been found in a fertile condition are removed to their appropriate natural genera, and we have seven of the more familiar species now described as species of the genus *Asterothea*. Some of the genera described, such as *Zeilleria*, *Telantrum*, and *Seftenbergia*, are of considerable botanical interest on account of the form of their reproductive structures. The records of the exact horizons and localities of each species in Britain are given, and this should prove of great value not only in the recognition of the horizons of coal seams, but also for the study of the evolution and distribution of the Carboniferous flora.

H. H. T.

The Pliocene Mollusca of Great Britain: being Supplementary to S. V. Wood's Monograph of the Crag Mollusca. By F. W. Harmer. Vol. 2, Part 4. (The Palæontographical Society: Volume for 1922.) Pp. xiv + 857-900 + 1 plate. (London: Printed for the Palæontographical Society, 1925.)

ALTHOUGH the preparation of this monograph was begun very late in life, the author lived to complete his work, but not to see the publication of the concluding portion. The first part was issued in 1914, and the author died in April 1923. Since the appearance of Searles V. Wood's great monograph on the "Crag Mollusca" (1848-57), with its Supplements (1872-82), there has been much progress in conchology and considerable additions have been made to the

already known rich fauna of the English Pliocene deposits, especially to that of the Waltonian Crag. Consequently, during his stratigraphical investigations F. W. Harmer found that a supplementary monograph was needed. The present memoir deals mainly with the gastropods and is illustrated by 65 excellent plates. The author's work on the stratigraphy of the Pliocene deposits of East Anglia and Western Europe, and his interesting conclusions concerning the physical conditions of the period, have been published in the Quarterly Journal of the Geological Society and elsewhere, but a few further points of general interest are given in this monograph, such as his discussion of the supposed Miocene age of the Lenham Beds.

[Sir Sidney Harmer informs us that he has a few copies of Vol. 2 of the above monograph, and he would be glad to hear from workers on Pliocene Mollusca who received copies of Vol. 1 but have not yet had Vol. 2.—ED.]

Evolution, Heredity, and Variation By D. Ward Cutler. Pp. 147. (London: Christophers, 1925.) 3s.

THE purpose of this book is, in the words of the preface, "to present, in as simple a manner as possible, some of the results of modern research on the great questions of evolution, variation, and heredity." The book is designed mainly for the use of schools in which biology receives a place in the curriculum, and for the general non-scientific reader who is interested in the bearings of these problems on questions of human sociology. It naturally contains nothing that is new, nor even a new viewpoint, and the author has had to make rigorous selection of available material in order to present the various aspects of the questions in as complete and impartial a manner as the exigencies of space would allow.

On the whole, Mr. Cutler has done his work well. It is almost inevitable in a book of this kind that the author should tend to be dogmatic, and this attitude is rather emphasised by the author's somewhat stilted and peremptory style. We should, for example, have preferred a less summary statement on the question of the inheritance of acquired characters, and a little fuller presentation of the more recent work on this baffling problem, especially in view of the reaction towards Lamarckianism, of which signs are not wanting, and of the grave importance of the matter in its bearings on human sociology. But this is, perhaps, a small point in an otherwise well-balanced book, which should be found very useful for the higher forms of schools where biology is taught for one or other of the school leaving certificates.

The Negro and his Songs: a Study of Typical Negro Songs in the South. By Prof. Howard W. Odum and Guy B. Johnson. Pp. ix+306. (Chapel Hill: University of North Carolina Press; London: Oxford University Press, 1925.) 13s. 6d. net.

THIS is the first volume of a series in which the story of the United States negro is to be presented. It comprises songs from Northern Mississippi, Northern Georgia, and a few others, chiefly from North Carolina and Tennessee. The types included are religious songs, social songs, and work songs, the last named being, perhaps, the most attractive from their purely rhyth-

mical effect. The two earlier classes are, however, the more instructive in the light they throw upon the mentality of the negro; and no one who reads through the whole of the social songs, with their peculiarly frank exhibition of the negro's attitude towards sexual feelings and relations, can fail to appreciate one side of the race problem in the United States. This, however, is not the whole story, and the religious songs show another side. Throughout there is ample evidence of the negro's gift of imagery, of graphic description, and above all of appreciation of dramatic effect. Amusing examples are given which illustrate the fact that the negro has not lost the gift of improvisation which other primitive singers have, or their impish delight in bringing into their songs any white man who may be present. The authors make an eloquent plea for the systematic study of negro culture, which readers of this volume will heartily support.

Le calcul des probabilités à la portée de tous Par Prof. Fréchet et Prof. Halbwachs. Pp. xi+297. (Paris: Libr. Dunod, 1924.) 18 francs.

TO mathematicians of the seventeenth and eighteenth centuries, the main interest of the theory of probability, then a new object of curiosity, lay in its application to games of chance. In more recent times this theory has developed in such a way as to occupy a central place in many theoretical and applied sciences, from astronomy and physical chemistry on one hand to biology and sociological science on the other. Probability is also the foundation of statistical work, which forms the basis of economics and of actuarial science.

Most treatises on probability, like Laplace's classical "Probabilités," involve some acquaintance with mathematics, and a reader without a working knowledge of the calculus usually finds them too formidable. In the volume before us, Profs. Fréchet and Halbwachs lucidly expound a variety of investigations in the subject which require no wider mathematical knowledge than that of elementary algebra. The questions discussed belong to a wide range of sciences, and the book will be a useful one to readers who are interested in the applications of probability but have only scanty mathematical attainments W. E. H. B.

A Treatise on Light. By Dr. R. A. Houstoun. Fourth edition. Pp. xi+486+2 plates. (London: Longmans, Green and Co., 1925.) 12s. 6d. net.

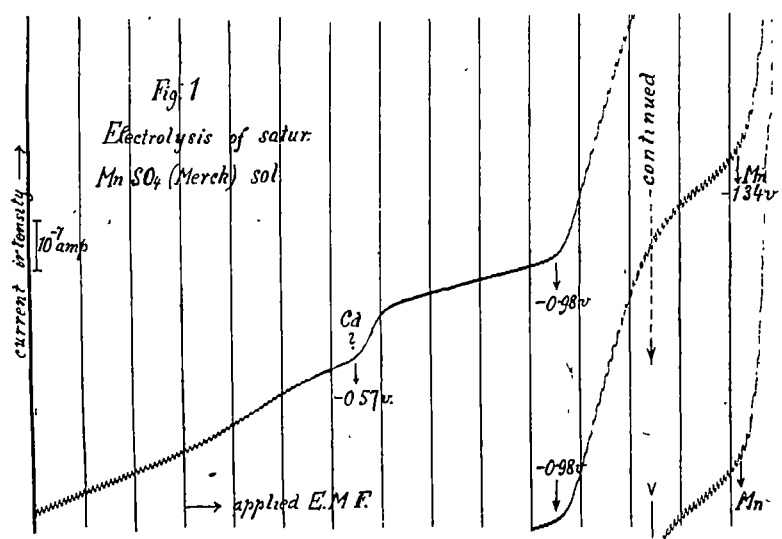
DR. HOUSTOUN has now remedied one rather serious defect in his well-known "Treatise on Light," namely, the out-of-date character of the section dealing with spectral series. That some modification was desirable will be apparent from the remark still to be found in the third edition (1923) that "all attempts to explain the origin of spectral series are regarded as unsuccessful." In the present edition a brief non-mathematical account of Bohr's theory is introduced, and some of its simpler applications, as to the spectra of hydrogen and ionised helium, are considered. Only a very few pages are devoted to this, for in the author's view the quantum theory of spectra belongs rather to mathematics and the theory of atomic structure than to light. It is perhaps debatable ground, like so much else in modern physics, but those who do not share his opinion will doubtless temper their criticism with appreciation of the many merits of the book in other respects.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Occurrence of Dwi-Manganese
(At. No. 75) in Manganese Salts.

IN investigations of the electrolytic deposition potentials of manganese solutions by the use of the dropping mercury cathode and the automatically registering "polarograph," comparatively large impurities (1:20,000) were detected even in the purest samples, e.g. Kahlbaum's or Merck's "pro analysi." (Cf. *Rec. Trav. Chim. Pays-Bas*, 44, 1925, 488-600.) From the position of the hump on the current-voltage curve (Fig. 1), the impurity was at first thought to be zinc (*l.c.* p. 520). However, on closer examination, the "saw-like" character of the undulations showed that this increase of current must be due to the deposition of a



metal or metals not alloying with mercury (*l.c.*). At the potential at which the manganese impurity is distinctly shown, i.e. at -1.0 volt (from the calomel zero), zinc, nickel, cobalt, and iron may be deposited from their 10^{-6} molar solutions (cathodic potentials 1.00, 1.06, 1.20, and 1.27 volts respectively). From the different heights of the humps on the polarographic curves, the impurity in the manganous solutions can be estimated as $0.5-4.0 \times 10^{-4}$ equiv. per litre, varying in different specimens within these limits. As analytical tests for zinc, nickel, cobalt, and iron in these solutions give negative results, these metals cannot be present in concentrations greater than 10^{-5} equiv. per litre. Hence the persistent impurity was suspected to be analogues of manganese—eka-manganese (43) and dwi-manganese (75).

The method of separation, first attempted in May 1925, consisted of dipping strips of zinc or platinum foils connected to zinc rods into concentrated manganous solutions; this would cause all metals having potentials less negative than zinc to be deposited. The deposit was scraped off, dissolved in a few drops of hydrochloric acid, evaporated to dryness or precipitated by sodium hydroxide and its X-ray spectrum examined.

Prof. M. Siegbahn's apparatus was used, as

described in his monograph. The $L\beta_1$ -line (Siegbahn's notation) of the element 75 was at once observed, the $L\alpha_1$ -line being masked by the $K\alpha_1$ -line of zinc. Owing to this superposition the wave-length of the zinc $K\alpha_1$ -line could not be accurately determined. Although this evidence did not seem sufficient to establish the new element, the authors have used it, in conjunction with the electrolytic method, to deduce some chemical properties of dwi-manganese. The impurity (1:100,000) causing the first hump was easily shown to contain no element 75, since it disappeared entirely from the graph when hydrogen sulphide was passed through the acidified manganous solution and the trace of precipitate thus formed gave on X-ray analysis no line of the element 75. The second "hump" was not affected by passing hydrogen sulphide through the acidic, or the sodium acetate solution, and when the solution was treated with sodium hydroxide, only the precipitated hydroxides showed the 75 line. Owing to the considerable amount of zinc which was introduced into the solution by the scraping, further polarographic investigation was inapplicable, and no progress was made until a few weeks ago, when the procedure was so modified that it yielded, in one operation, a pure X-ray spectrum of three lines of the 75 L series.

The method is as follows: Into a nearly saturated solution of pure manganous sulphate a small crucible containing manganese amalgam, prepared electrolytically, is introduced together with a large platinum foil which is connected to the manganese amalgam. After several days the platinum foil is removed, rinsed with water, and the deposit washed off with concentrated hydrochloric acid. The solution thus obtained is diluted with water, neutralised with sodium carbonate, and slightly acidified with acetic acid. Hydrogen sulphide is then passed to remove zinc, nickel, cobalt, and the metals of the first two analytical groups. The solution then remaining contains manganese with ca. 2 per cent. dwi-manganese, as shown from the spectrometric evidence

given by the hydroxides precipitated from this solution by sodium hydroxide.

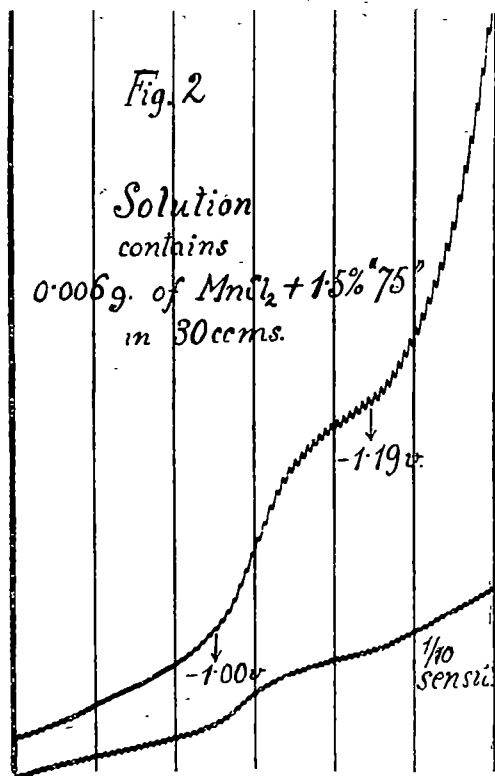
The simultaneous polarographic examination of the manganous solutions always reveals two impurity humps which constitute 2-3 per cent of the manganous content (Fig. 2). One, as shown previously, is due to the element 75; whether the other hump is caused by the element 43 could not be determined, as the coil used would not withstand the powerful exposure for the K-series of element 43.

Concentrated acidic chloride solutions containing element 75 are greenish although nickel has been carefully removed; the dry green chloride darkens rapidly to black on standing. Neutral chloride solutions containing element 75 deposit a yellowish-brown precipitate on standing in air, probably due to oxidation; this precipitation is avoided in the electrolytic method where the solutions are kept in an atmosphere of hydrogen. This seems to indicate that higher valency compounds of element 75 are more stable than those of manganese. In agreement with this is the fact that the manganous chloride prepared from potassium permanganate (Merck's "pro analysi") gives a polarographic hump six times as high as an equi-concentrated solution of manganous sulphate. This chemical behaviour

coincides with that mentioned by Dr. G. Druce (*Chem News*, 131, p. 273, 1925), whose results indicate the presence of element 75 in crude manganese compounds.

The provisional spectroscopic results are: $L\alpha_1 = 1430$ X.U., $L\beta_1 = 1235.3$ X.U., $L\beta_2 = 1204.3$ X.U., $L\gamma_1 = 1059$ X.U. The copper $K\beta$ -line was used as reference (M. Siegbahn and V. Dolejšek, *Zeitschr. f. Phys.* 10, 1922, 159). No lines of other elements appeared in the spectra of the final specimens except the copper K -lines. The $L\alpha_1$ -line could not be measured with the same exactness as the others since only the most recent specimens were entirely free from zinc.

W. Noddack, I. Tacke, and O. Berg claim (*Naturwiss.*, 1925, 26, 567) to have discovered the element 75 in columbite. As there published, their spectroscopic evidence is not conclusive, since two of their β -lines of the L series of element 75, according to their own data, coincide with those of tungsten;



moreover, their observed $L\beta_2 = 1204.8$ X.U. and their $L\beta_3 = 1216$ X.U. for element 75 happen to coincide exactly with $L\alpha_1 = 1204.7$ X.U., $L\alpha_2 = 1216.0$ X.U. for thallium. In view of the accuracy of their measurements, their observed lines agree with those of thallium better than with those calculated for element 75, namely, 1204.1 and 1216.9. They do not state whether the specimen was freed from thallium, a common impurity in such minerals, which in the presence of arsenic would accumulate with the insoluble sulphides; their "eka-manganese" should not be precipitated by hydrogen sulphide (cf. Dr. Druce's results). The only free $L\alpha_1$ -line they recorded, which by the ordinary Siegbahn dispersion is indistinguishable from the $K\alpha_1$ -line for zinc (difference ca. 1 X.U.), might be, at the abnormal dispersion they used, a new, hitherto unobserved, line split off from the zinc doublet.

From the scientific point of view the chemical character of the element 75 seems to the present

authors more suitably expressed by the old Mendeléeff designation of "dwi-manganese" than by "rhenium," as proposed by the German authors.

V. DOLEJŠEK.

J. HEYROVSKÝ.

Institute for Experimental Physics and
Institute for Physical Chemistry,
The Charles University, Prague,
November 4.

The Law of Force and the Size of Diatomic Molecules, as determined by their Band Spectra.

It is well known that from an evaluation of the vibrational energy of a diatomic molecule, as a function of the vibrational quantum number n , it is possible to deduce quantitatively the law of force of the molecule, in the vicinity of the equilibrium position of the two nuclei. Now when the dipole rotates, the nuclear separation r increases, and the amount of this increase depends upon the forces called into play when the nuclei are displaced from the equilibrium distance r_0 . But these are the same forces which determine the frequency of vibration ν_0 and the vibrational energy. Hence, if neither the vibration nor the rotation is sufficiently violent to distort the electron orbits appreciably, there should be a direct connexion between the constants which enter into the vibrational energy function, and those which characterise the rotational energy.

Kratzer has obtained such a relation, in its first approximate form ($\nu_0^2 = -4B^2/D$), but in the few cases where this matter has been considered, the relation in question has been assumed rather than carefully tested. I have now, however, derived the following direct relations. If one assumes for the law of force the function $F = k_1(r - r_0) + k_2(r - r_0)^2 + k_3(r - r_0)^3$, etc., and for the rotational energy of a non-vibrating molecule the usual function $E_m = Bm^2 + Dm^4 + Fm^6$, etc. (where m is generally, but not always, an exact half-integer), then the k 's, I find, may be expressed as explicit functions of B , D , F , etc. Explicit expressions for the k 's in terms of the constants of the vibrational energy function may be obtained from the work of Born and Hückel (*Phys. Zeitschr.* 24, 1, 1923). From vibrational energy data it is possible to evaluate k_1 with great accuracy, k_2 and k_3 with fair accuracy, and in the case of HCl, even k_4 at least roughly (paper by Prof. E. C. Kemble, now in press). From rotational energy data it is possible to determine k_1 with fair accuracy, and in the case of CN, even k_2 at least roughly. The great difference in accuracy is due to the fact that the available data on rotation, in the case, for example, of CN, apply to a maximum value of $(r - r_0)/r_0$ of only three per cent., while the maximum observed amplitude of vibration is about fifteen per cent.

Using new measurements and calculations for the $\lambda 3883$ CN band, I have evaluated the rotational energy function, for the final (emission) state, up to $m = 91.5$, and from these data have obtained $k_1 = 16.12 \times 10^5$ dyne $\cdot$ cm $^{-1}$, $k_2 = -6.18 \times 10^{14}$ dyne $\cdot$ cm $^{-2}$. From the vibrational energy data, by the customary process I obtain $k_1 = 16.00 \times 10^5$ and $k_2 = -5.44 \times 10^{14}$. Considering the accuracy with which the rotational energy data must be known, to obtain a value even of k_1 , this agreement is quite remarkable, but can scarcely be accidental. It is to be emphasised in this connexion that the first set of values is obtained from an analysis of the energy of the molecule in a series of states in which it is rotating, but not vibrating, while the second set of values is deduced from the energy in a series of vibrating, but non-rotating, states.

Hence the two sets of data are entirely independent, and the agreement of the results is a real confirmation of the theory underlying this work.

In a similar manner I have obtained values of k_1 from the rotational and from the vibrational energy data, for the initial and for the final state of the CN, CuH, N_2 , and N_2^+ molecules, using for the rotational energy data the (O, O) bands $\lambda 3883$ CN, $\lambda 4280$ CuH, $\lambda 3914$ N_2^+ , and $\lambda 3371$ N_2 . The mean position of the doublets was used for the first three bands, and the middle component of the triplet for the last. The difference between the rotational and vibrational energy values of k_1 for the initial and final states respectively, for the four molecules in the order named, is -1.0 and $+0.75$, -1.7 and $+3.5$, $+0.4$ and $+2.2$, $+4.8$ and $+3.2$ per cent. In all cases the discrepancy is well within limits of error.

This quantitative agreement in the case of the two non-polar molecules N_2 and N_2^+ has an interesting consequence. As we now know, the successive lines forming the band series of such molecules usually alternate in intensity, and the explanation of this phenomenon has become a matter of considerable difficulty. The only promising explanation thus far is due to Dieke (*Zeit. f. Phys.* 31, 326, 1925), but it carries as a necessary consequence a reduction of the value of the moment of inertia to one quarter of the previously accepted value. A serious objection to such a reduction is the close correlation between the magnitude of the frequency of vibration and of the moment of inertia (using the older values), noted independently by several investigators (see, for example, Mecke, *Zeit. f. Phys.* 32, 823, 1925). This, however, is not necessarily a vital objection to Dieke's theory, since it may well be that there is such a correlation for both polar and non-polar molecules, but that the "correlation factor" is quite different in the two cases.

I now find that Dieke's interpretation of the band series of non-polar molecules, which involves halving the customary values of m in the expression for E_k , leads directly to a value of k_1 just four times as large as that obtained from the same rotational energy data, using the older theory. Hence the above quantitative agreements, which are based on the older interpretation, seem to offer conclusive evidence in favour of the usually accepted values of the moments of inertia of non-polar molecules, as against the new smaller values. This assumes of course that the value of k_1 as obtained from vibration is correct, and it may be noted that permitting the vibrational phase integral ($\int p dq$) to vary by only $h/2$ between adjacent possible values, would in turn lead to a value of k_1 four times as large. Since, however, Dieke's interpretation leads to no change in the assumed minimum possible variation (h) of the rotational phase integral, there seems to be no reason for modifying this fundamental postulate of the quantum theory, in the case of the vibrational phase integral.

RAYMOND T. BIRGE.

University of California, October 17.

The Variation with Depth of Certain Salts utilised in Plant Growth in the Sea.

DR. STANLEY KEMP and the scientific staff of the R.R.S. *Discovery* have been good enough to provide us with water samples which have rendered it possible to obtain information, long considered desirable, as to how far the depths of the oceans act as reservoirs of salts necessary for plant growth. The samples also enable a comparison to be made between the concen-

tration gradient found in these and in more southerly latitudes, between Lisbon and the Canary Isles.

The following determinations were made, and are shown in the table, along with the temperature records received from Dr. Kemp: alkalinity of the water, expressed as pH , namely, $\log 1/H$, where H is the hydrogen ion concentration in grams per litre; phosphate, expressed as phosphorus pentoxide, nitrate as nitrogen, and silicate as silicon dioxide, all three in milligrams per cubic metre, namely, parts per thousand million of sea water. The methods of analysis have already been described in the *Journal of the Marine Biological Association*, save that for nitrate, which forms the subject of a forthcoming paper by one of us.

Depth in Metres.	T. °C.	pH.	In mgm. per m ³ .		
			P ₂ O ₅ .	Nitrate-N ₂	SiO ₂
0	21.10	8.35	0	15; 11	220
10	21.10	...	...	7	
20	21.00	...	...	6	
30	21.00	...	...	...	
40	21.00	...	...	16	220
50	20.01	8.35	0	ca. 6	
75	17.31	8.31	5	6	
100	15.10	8.18	8	55	
150	15.06	8.16	10	65	250
200	13.86	8.11	22	100	
300	12.25	8.12	44	178, 158	
500	10.94	8.00	50	200	
1000	9.55	8.03	74	264; 262; 274	450
2000	4.81	7.94	78	ca. 265	480
3000	3.10	7.87	88	ca. 265	1200

These figures show a marked gradient in pH , due mainly to the activity of the phytoplankton in removing carbon dioxide, but in part also the high surface values are due to the high temperature altering the equilibrium between bicarbonate and atmospheric carbon dioxide. The persistence of high alkalinity down to 75 metres is doubtless associated with the more intense illumination of the southern regions. The samples were taken at $37^{\circ} 44' N$, $13^{\circ} 21' W$. on Oct. 12, save that at 3000 m., which was taken on Oct. 16 at $29^{\circ} 59' N$, $15^{\circ} 03' W$. They were analysed on Oct. 30-Nov. 2, in a comparatively fresh condition, though minor changes may have occurred.

Quite in keeping with the pH values are those for phosphate and nitrate. The complete removal of phosphate down to at least 50 m. shows that, as previously reported, lack of phosphate sets a limit to the multiplication of the phytoplankton. The corresponding low values for nitrate indicate that this constituent runs phosphate close as a limiting factor; indeed it is possible that it does limit growth under certain conditions, for in early August in the English Channel this year some regeneration of phosphate had occurred, but down to the bottom, 70 m., only traces of nitrate were found.

Once the illumination becomes inadequate, both phosphate and nitrate increase, so that in the deeper waters they accumulate; not until upwelling occurs, when the deep water is moved to good illumination, are these supplies again available for plant growth; from this it follows naturally, as suggested by Nathanson, that oceanic banks are noted fishing grounds, for the phytoplankton constitutes the ultimate food source of oceanic animals.

The silica analyses show that while much silica is removed—by the diatoms—from the upper water, lack of silica is not under these conditions a factor

limiting diatom growth. The values given may be somewhat high owing to the solution of silica from the glass during storage. Tests with similar bottles leave, however, little doubt as to the substantial accuracy of the conclusions reached from the figures given here.

W. R. G. ATKINS.

H. W. HARVEY.

Marine Biological Laboratory,
Plymouth, November 6.

The Stokes-Planck Theory and the Michelson-Morley Experiment.

It seems to have been implied, in recent discussions, that the Stokes-Planck ether theory, while correlating the facts of astronomical aberration and other first order phenomena having to do with the earth's motion, is also in harmony with Prof. Miller's recent experiments in which he concludes that there is an ether drift relative to the earth, amounting to zero at the earth's surface and to something of the order of 10 kilometres per second at the altitude of Mount Wilson. It would appear that this conclusion cannot be substantiated.

It will be recalled that the original Stokes' theory was unsatisfactory because, when the velocity normal and relative to the spherical boundary was assigned (its value being in fact zero), the problem for irrotational flow was uniquely determined, and the solution gave finite and indeed considerable tangential relative velocities at the surface. The Planck generalisation introduced the idea of a variable ether density, and, by making the ratio of the density at the surface to that at infinity sufficiently large, it was possible to make the tangential velocity as small as desired.

On looking more closely into the analysis, however, it appears that the Planck solution serves to determine the way in which the tangential velocity varies with altitude in the vicinity of the sphere, and denies the possibility of any such change as 10 kilometres per second for a change of altitude of 1.7 km.

Thus, referring to the solution as given in Note 67 of Lorentz's "Theory of Electrons," we have for the velocity potential

$$\phi = z \left[a \left(\frac{\mu\omega}{2r} - 1 \right) + b \left(\frac{\mu\omega}{2r} + 1 \right) e^{-\frac{\mu\omega}{r}} \right], \quad (1)$$

where

$$b - a = w_0$$

and

$$a = \left(\frac{\mu^2\omega^2}{2R^2} + \frac{\mu\omega}{R} + 1 \right) e^{-\frac{\mu\omega}{R}b},$$

and where μ and ω are constants, R is the radius of the earth, w_0 the relative velocity parallel to the axis of z at infinity. The origin is at the centre of the sphere, r is the radius vector, and z the distance from the origin parallel to w_0 .

From the above it is easy to show that, if V_R and V_{R+h} are the horizontal relative ether drifts for $z=0$ at $r=R$ and $r=R+h$ respectively, where h is a relatively small increment in r ,

$$\frac{V_{R+h} - V_R}{V_R} = \frac{h}{R}$$

Hence, if $h=1.7$ km, and R is the radius of the earth (6400 km.), it is obviously impossible to have the change of velocity $V_{R+h} - V_R$, which Miller concludes to be 10 kilometres per second, comparable even with the quantity V_R which the object of the large density ratio is to render negligible.

W. F. G. SWANN.

Sloane Laboratory,
Yale University.

NO. 2926, VOL. 116]

The Chromosome Complex of *Gammarus chevreuxi* Sexton.

THE spermatogenesis of *Gammarus chevreuxi* having been investigated by me at the Plymouth Laboratory of the Marine Biological Association, it was considered desirable, in view of the genetic interest of this form, and of the fact that detailed results will not be published for some months, to summarise briefly the essential conclusions. These are.

(1) The chromosomes of *Gammarus chevreuxi* are small, ovoid and minutely heteromorphic, and have a diploid number in the male of twenty-six, this number being arrived at by the study of a large number of spermatogonia, and also of spermatocytes and synapsis stages.

(2) This chromosome number includes in the male an X and a Y chromosome, the former being larger, and the latter smaller than any of the autosomes.

(3) The spermatogonial metaphase plates fall into two distinct classes as regards chromosome size. There is considerable evidence that the large plates are merely the later stages of the spermatogonial series.

(4) While *Gammarus* does not provide favourable material for the detailed study of synapsis, the chromosomes appear to spin out in the typical way in the early synaptic stages.

(5) Preliminary studies of the embryonic chromosomes indicate that the somatic chromosome number is about twenty-six, but sufficiently favourable material has not yet been obtained to warrant any more definite statement.

RICHARD PALMER

Royal Grammar School,
Worcester, November 5.

The Solar Constant and Terrestrial Magnetism.

DR. CHREE has obligingly sent me a copy of his paper entitled "The Relationship between the 'Solar Constant' and Terrestrial Magnetism" (*Proc. Roy. Soc. A* 109, 1925). He finds no indication in the solar constant data of 1918-1924 of a repetition of departures after a solar rotation period. This finding is quite in accord with ours. We have, indeed, noted the solar rotation period very plainly in some of the data, but only for a few months at a time, as in the year 1915. (See C. G. Abbot, "On Periodicity in Solar Variation," *Smithsonian Miscellaneous Collections*, vol. 69, No. 6, 1918).

In the second place, Dr. Chree does find indications of magnetic disturbance associated with low values of the solar constant. Inasmuch as higher solar constant values are generally associated with numerous sun-spots, and abundant magnetic disturbances, he thinks this paradoxical finding of low solar constants associated with magnetic disturbances is non-significant. On the contrary, it is exactly what we should expect.

Referring to a recent paper (C. G. Abbot, "Solar Variation and Forecasting," *Smithsonian Miscellaneous Collections*, vol. 77, No. 5, page 23, Figs. 15 and 16), the passage of an individual sun-spot group over the central meridian of the solar disc is almost always associated with decreased values of the solar constant, and doubtless frequently with terrestrial magnetic disturbances. Hence, it is prevaillingly with low rather than high solar constant values that individual magnetic disturbances will be found associated.

C. G. ABBOT

Smithsonian Institution,
Washington, U.S.A.,
October 26.

Examination of Bronze Implements.

By Prof. C. O. BANNISTER and J. A. NEWCOMBE.

THE results of modern methods of research on the constitution of metallic alloys and on the effects of varying mechanical and thermal treatment on their structure and mechanical properties have increased our knowledge of these subjects enormously. Of these methods, the use of the microscope for the examination of the micro-constitution and crystalline condition of suitably polished and etched specimens is one of the most important. This method of examination is capable of indicating not only how the component metals exist in the alloy, but also what mechanical or heat treatment the alloy has undergone. As regards constitution, the microscopical examination is used in order to ascertain whether the component metals are present in the free state, in chemical combination, or mutually dissolved and retained in solution in the solid state. As regards treatment, the structure observed is used to decide whether the metal object was obtained by a casting process or was shaped by mechanical work, and is also capable of indicating whether any work has been applied to the object and also whether this work has been followed by an annealing process. Below are given some results of an examination of a chisel and a palstave of the Bronze Age found about 1898 in a brick-field near the Hanwood-Shrewsbury road and supplied by Mr. F. Drinkwater of West Kirby through Miss L. F. Chitty of Yockleton, near Shrewsbury.

With regard to the constitution of bronzes, these consist of alloys of copper and tin in varying proportions, and if the molten metals be allowed to solidify and cool very slowly, or if cooled normally and then reheated for the necessary length of time, the tin is soluble in the copper in the solid state up to 13 per cent. of tin. After such treatment, the bronze would show one constituent only under the microscope.

On cooling a liquid alloy containing 8-13 per cent. tin, the first portions to solidify are richer in copper than the portions solidifying last. On polishing and etching such an alloy, these copper-rich portions are found to have a fern-like structure, and the presence of these dendrites, as they are called, is indicative of cast metal. The alloy not being homogeneous throughout its mass has areas with a greater tin percentage than 13, and in these areas a pale blue constituent, which is a very intimate mixture of two solid solutions, makes its appearance. The more of this second constituent that is present the harder and more brittle does the metal become, and with any definite percentage of tin the more quickly the metal is cooled, within limits, the more of this constituent is present in the casting. If the cast bronze be now heated for some hours at a temperature below its melting point, diffusion takes place, the metal becomes more or less homogeneous in composition, and the dendrites and the second constituent more or less disappear, the metal becoming more homogeneous the longer the annealing or the higher the temperature. With cast bronze of less than 8 per cent. tin, the dendrites would appear as above, but little or no blue constituent would be present because the tin rich areas would contain less than 13 per cent. of tin.

If the cast metal were cooled in the mould very slowly, this would have, as regards the homogeneity of the metal, a similar effect to annealing. The rate of cooling of a casting will depend on three factors: first, the temperature of the metal when it is cast, it being obvious that the higher this temperature the longer will the solidifying and cooling take. Secondly, the material of which the mould is made. If the material conducts heat rapidly from the metal, the rate of cooling will be greater than in the case of a mould from which the heat was less rapidly removed. The stone mould commonly used for casting antique bronzes would be a bad conductor of heat, and the cooling would take place very slowly. A bronze mould would chill the casting, and cooling would be very rapid. A sand mould would have an effect intermediate between these two. The third factor would be the size of the casting, one of large bulk cooling more slowly than a smaller casting, as there would be more heat to disperse.

Another important characteristic in the structure of bronze is the outline of the crystals revealed by the etching. In the cast metal the crystals are very irregular, some crystals being of large size compared with others, and having interlocked boundaries. If the metal be now worked in some way by hammering or rolling, an examination will show the results of this work in the distortion of the original crystals, which are often elongated to a considerable extent at right angles to the direction of the work when this has been excessive. The effects of less drastic amounts of work are seen in the appearance of parallel lines on the crystals, these lines being known as slip bands. If the metal be annealed after working, new crystals will make their appearance, appearing quite different from the casting crystals and characteristic of the annealed metal. These crystals are much more uniform in size, and have sharp lines as their boundaries. They invariably show a great deal of twinning, which is recognised by the crystals having two or more parallel lines traversing them. As a result of this working the dendritic structure will be somewhat destroyed. Instead of being fern-like, it generally appears as thick, dark, irregular parallel bands over the specimen in a direction at right angles to the force applied. A long annealing entirely eliminates this structure, but the new crystals grow before this is effected, so that in annealed metal, traces of the dendrites may still be seen.

It will be gathered from these notes that much can be deduced from the micro-examination of antique bronzes. From the fern-like, dendritic, or core structure, as it is variously called, and the type of crystal boundaries, the cast structure is at once recognised, and with an 8-13 per cent. bronze some sort of deduction can be made as to the mould used, because with very little of the blue constituent present the metal would have cooled slowly, and it is probable that a stone mould would have been used. The twinned equiaxed crystals and the partial or total absence of dendrites indicate that the metal had been hammered and annealed.

Examination of Chisel.

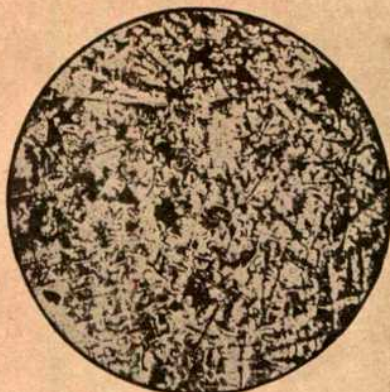
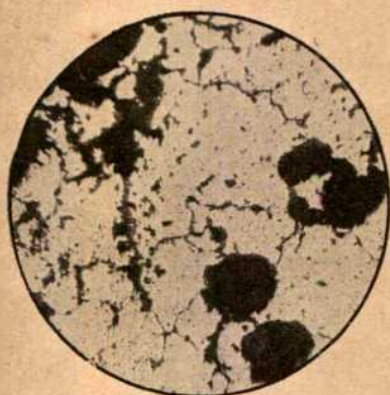
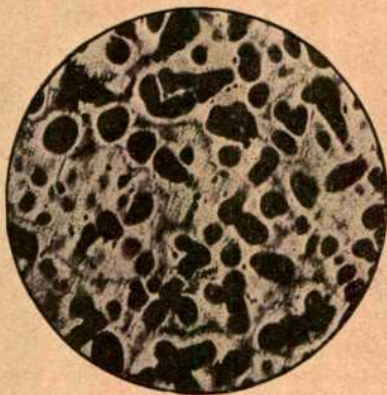
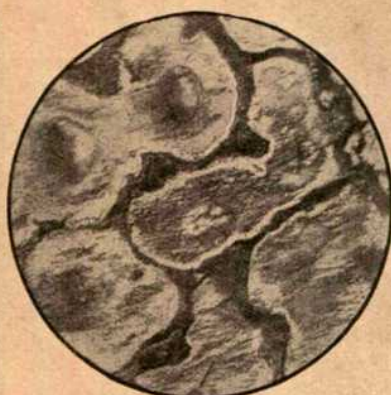
The chisel was 15.5 cm. in length and, as is shown in Fig. 1, was fractured when received. The fracture showed a considerable amount of porosity. An analysis shows copper 85.5 per cent., tin 14.2 per cent. A section taken of a part near the fracture was polished and etched in a solution of ammonia containing a few drops of hydrogen peroxide. Fig. 2 shows the dendritic structure at a magnification of 15 diameters. The section was again polished and photographed unetched. Fig. 3, at a magnification of 25 diameters, shows how very porous the metal is; the holes were formed at the

amount of blue constituent and the number of blow-holes would indicate the metal to be very brittle, and on examination the metal was found to be so brittle that it could be crushed by gentle tapping with a small agate pestle.

A very important matter brought out by the examination of this ancient chisel is the persistence of the dendritic or core structure, because it has been suggested that, during the course of a long time, even at ordinary atmospheric temperatures, diffusion would proceed in solid alloys, with the result that equilibrium would eventually be obtained exactly as it may be



FIG. 1.

FIG. 2. $\times 15$.FIG. 3. $\times 25$.FIG. 4. $\times 60$.FIG. 5. $\times 270$.

time of casting, and were due to the fact that the metal was cast at too high a temperature and insufficient provision was made for the escape of gases from the metal. Fig. 4 was taken to show the dendritic structure at the higher magnification of 60 diameters and is typical of cast bronze. Fig. 5, taken at a still higher magnification of 270 diameters, shows the blue constituent situated along the boundaries of the crystals. The percentage of tin present in the alloy would account for this apart from the heterogeneity of the metal.

From the well-defined dendritic structure and the large proportion of blue constituent, it may be assumed that the metal cooled quickly in the mould, the small bulk of metal being sufficient to account for this, apart from the nature of the material of the mould. The

obtained at higher temperatures in a few hours. The dendritic structure of this chisel, however, is so typical of a recently cast bronze that it appears safe to say that no diffusion has taken place during the ages.

Examination of Palstave.

The palstave examined is shown in Fig. 6, and is 15 cm. long. An analysis shows copper 86.9 per cent., tin 12.7 per cent. A portion of the socket was polished and a photomicrograph was made of a portion adjacent to the corrosion product at a magnification of 75 diameters; this is shown in Fig. 7. The corroding agent operates in the first place along the crystal boundaries, this being the portion of the metal in which any traces of impurities present become concentrated,

corrosion taking place more readily with impure than with pure material. The presence of corrosion of this type in bronze is a sure proof of its antiquity, and a check against the fraudulent "antiques" which are made with so much perfection at the present day. With recently cast bronze, although it is easy to imitate the effect of age on the outside by chemical means, age alone will allow the slow penetration of the corrosion around the crystal boundaries without too rapid attack on the crystals themselves.

Fig. 8 was very deeply etched by means of a solution of ammonia containing hydrogen peroxide to show the

A section of the cutting edge was polished and etched, and the photomicrograph is shown in Fig. 10, at a magnification of 75 diameters. The crystals shown here are much smaller in size and of a totally different shape from those of Fig. 9. They are more uniform in size, they are sharp, and a large number of them are twinned. It will be observed that indications of dendrites are almost entirely absent. This structure shows that this end of the palstave has been hammered and afterwards heated. There is little doubt that the hammering was performed with the object of sharpening or reshaping the palstave, and the reheating operation

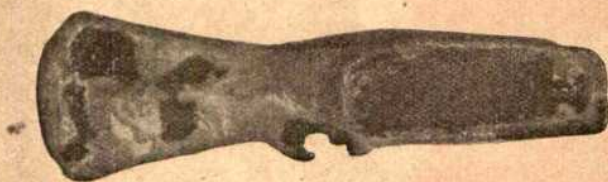
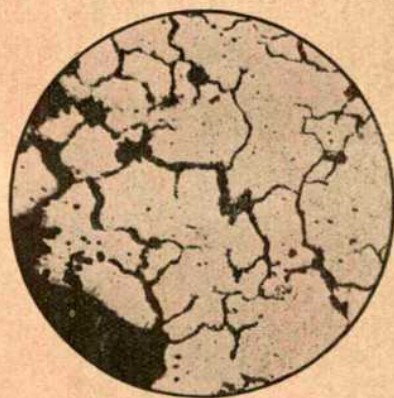
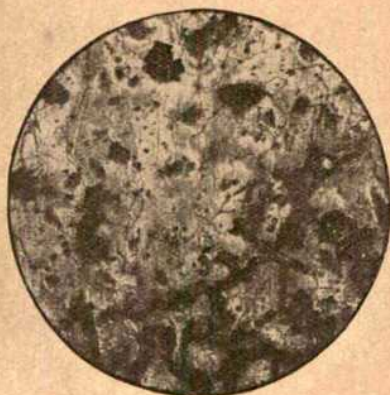
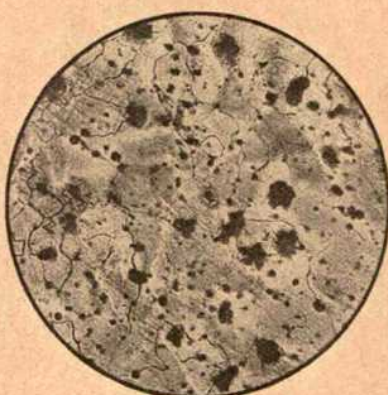
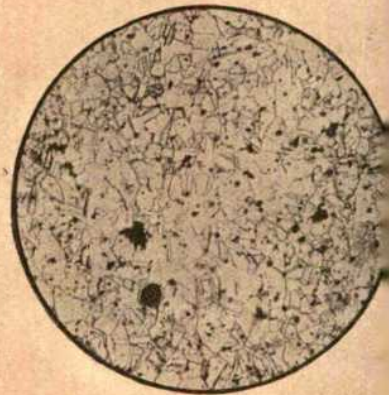


FIG. 6.

FIG. 7. $\times 75$.FIG. 8. $\times 70$.FIG. 9. $\times 75$.FIG. 10. $\times 75$.

type of crystals present. The very irregular crystals can be seen, and it will be noticed that the corrosion follows the crystal boundaries. Some of the crystals show striations across their surfaces and these are slip bands. These slip bands are formed when a metal is subjected to an amount of work just sufficient to cause a permanent deformation in them. This would naturally be towards the end of the socket where the metal is thinnest, and would be caused by the force exerted on this part by the wooden handle fitted on to the socket when the palstave was in use. The smaller dark patches in Fig. 9 consist of the blue constituent, but the larger are the result of corrosion.

Fig. 9 shows more clearly the shape of the casting crystals and illustrates variation of size and interpenetration.

was used to remove the brittleness induced by the work, as it would soon become apparent to the ancient metallurgist that these operations would give a stronger and tougher metal. The metal could not have been hammered hot, because bronze of this composition is not malleable when hot. The palstave was finally annealed, as otherwise the effect of the work would have been apparent on the crystals in the photograph.

From Figs. 8 and 9 it is evident that the dendrites are not well defined, and very little blue constituent is present although the composition is near the maximum at which tin is soluble in copper. This is due to the comparatively long time the metal took to solidify and cool, thus allowing some diffusion to take place in the solid metal, and the composition to become approximately uniform.

It has been suggested that if an antique metal had been worked or strained, crystals may form at ordinary

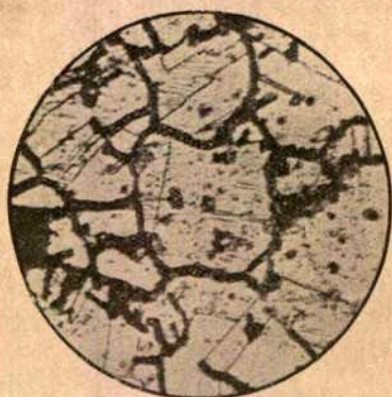


FIG. 11. $\times 300$.

temperatures during the ages similar to those that would be formed in a short time if the metal were

heated. The evidence obtained from the examination of this palstave appears to prove that this is not so in the case of bronze. Fig. 11 is a photomicrograph of a portion near the cutting edge of the palstave and is similar in appearance to the structure shown in Fig. 10, but at a higher magnification of 300 diameters. This photograph was taken in order to illustrate the fact that corrosion on this part of the palstave follows the crystal boundaries, which are not of the casting crystal type but have been formed subsequent to mechanical work. The presence of the corrosion product in these boundaries indicates that these crystals must have been in existence before corrosion commenced and therefore had not been slowly formed during the ages. This photograph also shows that the crystals are still of the same size as they were when corrosion commenced and that no growth has taken place. This suggestion of the germination of crystals during the enormous time that has elapsed since the castings were made is further disproved by Fig. 8, as the slip bands shown in this photograph indicate strained metal and no new crystals are seen to have formed.

The Darling and Lothian Foundations for Research in Malaria.

SOME months ago we had to record (*NATURE*, May 30, p. 845), with much regret, the deaths in a motor-car accident, near Beirut in Syria, of Dr. S. T. Darling (United States of America), Dr. N. V. C. Lothian (England), and Mlle. Besson (France), members of the Malaria Commission of the League of Nations who, with Prof. Nocht (Hamburg), Swellengrebel (Amsterdam), Ottolenghi (Italy), Anigstein (Poland), and Colonel James (England), were undertaking a tour of investigation in Palestine, Syria, and part of Turkish Asia Minor. In the recently published report on the work of the fifth session of the League's Health Committee, held at Geneva on October 8-14, it is announced that the Committee, wishing to honour and perpetuate the memory of Dr. Darling and Dr. Lothian, has decided:

(1) To collect by private subscription a capital fund, the interest on which will be expended on a prize to be awarded periodically. This will be known as "The Darling Prize."

The prize (a medal or other reward) will be awarded by the Malaria Commission of the League of Nations to a scientific worker who, in its opinion, has carried out recent distinguished research on a subject connected with malaria which comes within the general scope of the Commission's investigations.

(2) To devote a portion of the credits provided for in the budget of the Health Organisation for the encouragement of malariological study to the establishment of a periodical scholarship to be known as "The Lothian Scholarship." This scholarship will be awarded by the Malaria Commission to a selected candidate whose course of study should be in conformity with the general programme of the Malaria Commission.

In our issue of August 8, p. 216, we printed the substance of an appreciation, from the pen of Prof. R. W. Hegner, of the life and work of Dr. Darling. In the Malaria Commission's report of the Palestine tour, which preceded the journey to Syria on which the tragic accident occurred, it is said that the Commission had frequent occasion for congratulation that Dr. Darling had found it possible to be one of the party. "His

previous experience of malarial epidemiology and anti-malarial operations in many countries was unrivalled. He appreciated very clearly the particular aspect of the subject with which the Commission's mandate is chiefly concerned, and his observations during the tour constantly proved that he was at the zenith of his powers as an expert adviser on antimalarial work."

Dr. Lothian joined the Secretariat of the Health Section of the League in May 1923, after a career of considerable achievement in the Royal Army Medical Corps. He had specialised in hygiene, and some of the scientific papers which he published during his army service were of outstanding merit and practical usefulness, notably his "historical inquiry into the load carried by the soldier of various periods," in which he showed that a soldier should not be required to carry more than 33 per cent. of his own weight; the load of a mule is 32 per cent. and of a horse 28 per cent., and to require a soldier to carry more than 33 per cent is to destroy his marching power and capacity for battle.

Dr. Lothian, during his two years' service with the League, travelled in many countries and came into close contact with administrators and public health officers of many nationalities. He accompanied and guided the "interchange courses" of foreign public health and medical officers which, in collaboration with the Rockefeller Foundation, now form a regular item in the programme of the Health Organisation at Geneva. He was secretary to the League's Malaria Commission, and in the report of the Commission's tour of investigation through eastern Europe and Russia, which was published last year, the chapter entitled "Summarised Impressions of the Tour" was wholly drafted by him. It is a sufficient illustration of his expert knowledge of the subject and of the industry which characterised all his work. His high sense of duty and his attractive personality gained him the highest regard and respect wherever he went, and the shock of his death was the greater because he was in the exuberant vigour of youthful manhood, looking forward with enthusiasm to the highest and best that life holds in store.

The Total Solar Eclipse of January 14, 1926.

NUMEROUS parties have been organised to observe the solar eclipse on January 14 next, which is total in central and eastern Africa, Amirante Islands, Sumatra, Borneo, etc. (Fig. 1). The duration of totality is $2^m 12^s$, and the sun's altitude about 26° on the African coast, which is to be occupied by Signor Horn d'Arturo. The Amirante Islands will not, apparently, be occupied, the meteorological conditions being unpromising.

Most of the parties will be stationed in Sumatra,

stood that this shift will be investigated by a party from Potsdam, stationed near Palembang, and by Prof. Miller of Swarthmore Observatory, who will use a coronagraph of 60-feet focus.

Several other parties from the United States will also go to Sumatra, representing the Observatories of Harvard, Mount Wilson, and Washington (Naval); the names of Messrs. Anderson, Littell, and Stetson have reached us as belonging to these parties.

Messrs. Vanderbilt and Voute are going from Java

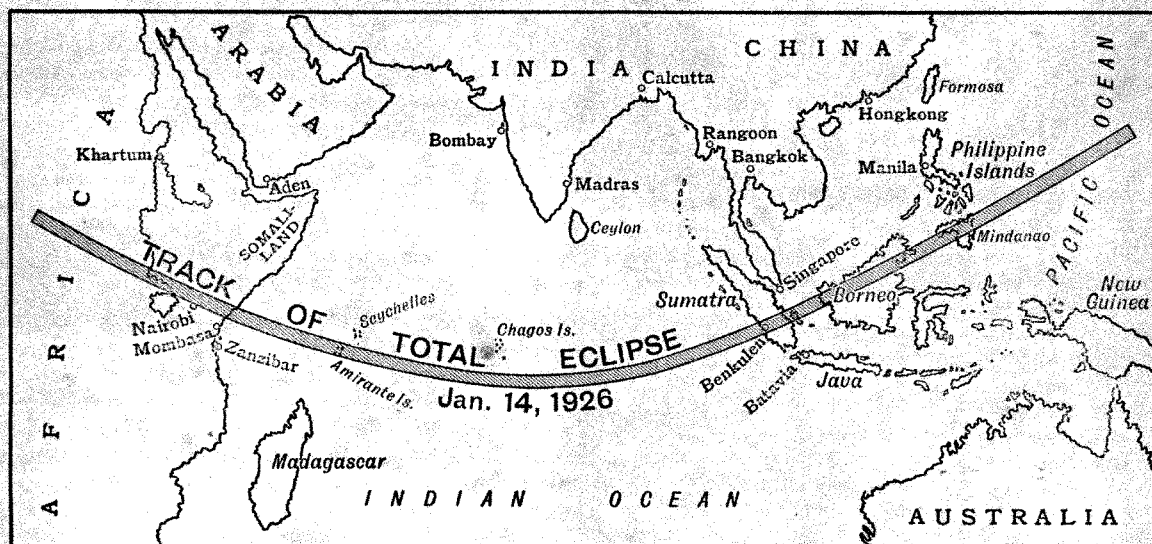


FIG. 1.—Map showing the track of the solar eclipse of January 14, 1926.

Emery Walker Ltd. sc.

where the duration of totality will be about $3^m 13^s$, and the sun's altitude 54° . Benkulen, on the west coast, is near the central line; the British party, consisting of Col. Stratton, Mr. C.R. Davidson, and others, will be stationed here. They will reach Benkulen via Palembang on the river Musi, the landing of heavy packages at Benkulen being difficult. They are taking two coelostats and the Copeland coronagraph lens of 40-feet focus, which has seen service at several eclipses. Their work will be wholly on problems of solar physics, the "Einstein" shift being considered as sufficiently established in 1919 and 1922. It is, however, under-

to Palembang. There is no news to hand of any parties occupying the islands east of Sumatra. This is the second time that Sumatra has been visited by eclipse expeditions in the present century; there was a very long totality there in May 1901, when Sir Frank Dyson, among many others, made successful observations, though the weather conditions were not wholly propitious. There will be another totality in Sumatra (northern part) on May 9, 1929, with high sun and more than 5 minutes' totality. The island will then have a rest until March 18, 1988, which is a return of the Indian eclipse of 1898 after five saroses.

Obituary.

PROF. JEAN MASSART.

BRITISH botanists will have learnt with regret of the death of Prof. Jean Massart, of the University of Brussels, which occurred somewhat suddenly at Houx, a little village on the Meuse, in August last. Prof. Massart had retired thither to recuperate, his health being possibly impaired by a long journey in Brazil with some of his students, followed by a strenuous lecture tour in America.

Born in 1865 at Etterbeek, a suburb of Brussels, Prof. Massart obtained his doctorate in science at the University of Brussels and became professor there in 1895. His early researches turned upon general biological problems, such as chemotaxy, pathologic

infection by micro-organisms, immunity, etc. From a study of the lower organisms, especially flagellates and fungi, he passed gradually to still more botanical fields of work. After the death of his former teacher, Prof. Léo Errera, he was nominated director of the Institut Léo Errera, and a great deal of his botanical work is published in the memoirs of the Institute. His early work upon the lower forms of plant and animal life has imparted a distinctive character to his recent text-book, the "Éléments de biologie générale et de botanique." Prof. Massart, however, is probably most widely known outside Belgium for his beautifully illustrated vegetation studies, especially of the polder country. His account of the recovery

of the vegetation in the devastated region of the Belgian battle front was referred to in *NATURE* (vol. III, p. 97, Jan. 20, 1923).

During the War, Prof. Massart's outspoken comments upon the actions of his country's invaders led to his enforced departure, and he found refuge first in Holland and then in France. During this period he continued botanical work so far as possible, and also tried by various means to raise funds for the aid of necessitous fellow-countrymen, Red Cross work, etc. Prof. Massart was back in Brussels in January 1919, where the present writer found him busily engaged in re-establishing order in Institute and Botanic Garden. Students were gathering around him and further investigations were already projected or in progress.

A quiet, forceful personality, immersed in his scientific work and the interests of the students under his guidance, Prof. Massart's departure makes a gap in the ranks of Belgian botany that will not easily be filled.

J. H. P.

THE funeral took place in Paris on November 3 of M. Eugene Tisserand, for many years a most prominent figure in French agriculture. Born at Flavigny-sur-Moselle, he lived to the great age of ninety-five years. In 1850 he entered the recently founded Institut Agronomique at Versailles. After a distinguished student career he spent five years in visits to other countries, studying their methods of agriculture. On his return he set about the task of enriching large areas of poor agricultural land. After the war of 1870 he was appointed Inspector-General of Agriculture, and he commenced his great campaign in favour of the furtherance of scientific agriculture in France. In 1879 he was appointed director of the newly reconstructed Institut Agronomique. At the same time he

was Director-General of Agriculture. Under his directorship the study of agriculture spread rapidly, and he was instrumental in establishing new laboratories and institutes. In the little time he had to spare from administrative duties he was engaged in research, and among his chief publications are "Economic Studies of Denmark and Schleswig-Holstein," "Vegetation of High Altitudes," and "The Low Temperature Treatment of Milk." He was a member of the Paris Academy of Sciences and also of the Academy of Agriculture, of which he was president in 1911. For many years he was chairman of the editorial board of the *Journal of the Institut Agronomique*. For his services to agriculture he was awarded the Grand-Croix de la Légion d'Honneur. The passing of so notable a figure is a great loss to French agriculture.

WE regret to announce the following deaths:

Prof. J. Guiteras y Gener, professor of general pathology and tropical diseases in the University of Havana, president of the Cuban National Board of Health and a founder of the *Revista de Medicina Tropical*, whose name is associated chiefly with the campaign against yellow fever, aged seventy-three years.

Dr. George Reid, formerly medical officer of health to the Staffordshire County Council, who was known as an authority on sewage disposal with reference to bacterial filtration and as the author of "Practical Sanitation," on November 6, aged seventy-one years.

Canon C. H. Robinson, editorial secretary to the Society for the Propagation of the Gospel, formerly lecturer in Hausa in the University of Cambridge and the pioneer white man in Hausaland, on November 23, aged sixty-four years.

Prof. H. J. Waters, president of the Kansas State Agricultural College from 1909 until 1917, who was known for his work on the nutrition of farm animals, on October 26, aged fifty-nine years.

Current Topics and Events.

THE death of Queen Alexandra on November 20, when within a few days of the end of her eighty-first year of age, has aroused world-wide expressions of regret and brought Great Britain and Denmark close together in sorrow at the loss of one whose memory will long be cherished with affection in both countries. From the moment when, as Princess Alexandra, she arrived in England in 1863 for her wedding with the Prince of Wales, to the day of her death, the Queen-Mother occupied a place in the hearts of British people which can never be filled again. She was loved by all, and her sympathy and active interest were always forthcoming for any institutions or organisations which worked to promote human well-being. It was through her that the Finsen light treatment was first introduced into the London Hospital, of which she was president. While on a visit to her native city of Copenhagen, she was so much impressed with the good results obtained there by the treatment of lupus by light that she presented a set of the apparatus to the hospital and thus initiated here the treatment of disease by light, which has now a recognised place in the domain of therapeutics. While Princess of Wales, and as Queen

Consort when the Prince of Wales ascended the throne under the title of King Edward VII. in 1901, her royal and beautiful attributes did much to mould the character of our national life. She identified herself with many progressive movements, and with King Edward in 1909 opened the Victoria and Albert Museum and the new buildings of the University of Birmingham. Though Queen Alexandra has now passed into silence, her life and influence will be remembered with pride for many generations.

BIRTHDAY congratulations are due to Prof. J. Ambrose Fleming, who will be seventy-six years of age on November 29. Son of that well-known divine, the Rev. Dr. James Fleming, he was born at Lancaster, November 29, 1849. He was educated in the first instance at University College, London, and at St. John's College, Cambridge, and early enjoying the advantage of study under Sir Edward Frankland at the old Royal College of Chemistry, almost the whole of Prof. Fleming's long working life has been devoted to teaching, in University College, the theory of electricity and magnetism, together with its manifold developments and, in addition, the industrial

applications arising therefrom. In 1879 he was scientific adviser to the Edison Telephone Company; later, he was associated with the Edison-Swan Company, actively engaged on the arc lamp, its accessories, and incandescent lighting in general. In 1899, when wireless telegraphy was forsaking the abstract, Prof. Fleming was helping the Marconi Company. The electrical resistance of metals and alloys constituted the basis of researches with the late Sir James Dewar. Prof. Fleming received the Albert medal of the Royal Society of Arts at the hands of the Duke of Connaught, in 1921, in recognition of valuable contributions to electrical science and its applications and specially of his invention of the thermionic valve, so widely employed in wireless telegraphy and telephony and for other purposes.

THE year's work of the Imperial Cancer Research Fund was reviewed at the annual general meeting held on November 19. It is as usual a record of solid unhurried progress towards elucidating the nature and modes of origin of cancer. A few years ago it was discovered by Japanese workers that malignant tumours of the skin could be produced with ease and certainty by the application of tar or some of its components; this made available a weapon of further inquiry of the greatest value which has been vigorously exploited in many directions. Thus in the present report we find that Dr. Cramer has shown that denervated skin responds less readily than normal, and Dr. Findlay demonstrates that a single application of hot tar may be followed months later by the development of cancer, reproducing in this way experimentally what had been suspected from human experience and observed in the branding of sheep. Other researches on the influence of one tar cancer in inhibiting the development of another are in progress: they indicate clearly that changes in the skin in one part of the body may alter the skin everywhere. The other main line of investigation arises through Gye's recent clarification of Rous's old observation that certain fowl tumours could be transmitted by extracts which contained no cells. The fundamental experiments are being repeated by Dr. Begg with chicken sarcoma and the venereal sarcoma of dogs at the Fund's new laboratories at Mill Hill, where the work is carried on in close association with that of Gye at the establishment of the Medical Research Council next door. It is too early to discuss such results as have been obtained, but it is clear that the new methods provide possibilities of analytical experiment which enable many old problems to be attacked in a fresh way. The progress of cancer research at the moment is satisfactory. The new knowledge is nowhere discrepant with the old but is enabling us to add together a number of apparently disconnected facts into a coherent tale. Not the least of the services rendered by the Imperial Cancer Research Fund is its maintenance by continuous propagation through animals of a number of animal cancers which are always available for use in its own laboratories and in any other responsible hands when a new idea crops up which needs experimental testing.

IN the *Lancet* of November 14 there is a paper "On the Specific Character of Malignant Neoplasia," by Dr. W. Blair Bell, professor of obstetrics in the University of Liverpool. This paper was the subject of an address given at the Toronto Academy of Medicine, and press reports announced the view that the author had made an important addition to the knowledge and cure of malignant growths. Dr. Blair Bell holds that malignant tumour formation is a specific growth process and is a reversion, on the part of a cell that is starving, to the nutriment-seeking proclivities of its ancestral type, the chorionic epithelium. With the co-operation of other workers Dr. Blair Bell has confirmed the observation of Gye and Cramer (1913) that in certain rapidly growing malignant growths there is a high phosphatide content, approximating to that found in the chorionic villi. Experimentally it was found that certain compounds of lead have a specific action on the chorionic epithelium leading to its death. From the chemical analogy between chorionic epithelium and cancer tissue, it was argued that lead might be expected to have a destructive action on the latter and such indeed it is claimed to have. A considerable number of cases of malignant growths have been treated and two of the successful cases are published by Dr. Blair Bell in some slight detail. Dr. Blair Bell hopes, however, that less toxic and more potent chemicals than lead will be discovered in further study.

THE controversy on the alleged transmutation of mercury into gold by Prof. Miethe still continues. It will be remembered that Prof. H. Nagaoka communicated to our columns (*NATURE*, July 18, p. 95) his production of ruby glass by means of a discharge between tungsten and mercury electrodes in paraffin oil, and also that E. Tiede, A. Schleede, and F. Goldschmidt (*Die Naturwissenschaften*, August 28, p. 745) failed to detect any trace of gold in mercury that had been treated by Miethe's method after it had been twice distilled in a high vacuum. The *Scientific American* (November 1925) now reports a similar failure from the experiments performed by Prof. H. H. Sheldon and R. S. Estey, of Washington Square College, University of New York. Initially, these workers used a specially constructed quartz-lamp provided with electrodes made of pure tungsten, and redistilled gold-free mercury obtained from a natural source. They operated the lamp for three separate runs, ranging from 30 to 50 hours, with voltage 170 and current strength 13 amp., and if Prof. Miethe's contentions are correct, they should have obtained at least ten times the amount of gold that could be detected by the analytical tests employed. The experiments were repeated, using an exact replica of Prof. Miethe's lamp, and following his *modus operandi* in every detail, but purified natural gold-free mercury was again employed. As no trace of gold was found in any of the tests, the authors suggest that the mercury used by Prof. Miethe was not sufficiently purified. In Germany, Prof. E. H. Riesenfeld and W. Haase have recently found that

ordinary mercury can only be freed from gold by repeated slow distillation *in vacuo*; according to them, all mercury on the market contains gold, and all the metal that has hitherto been used in transmutation experiments contained that element

DR. F. GOLLA writes to say that he finds it difficult to understand how our correspondent, in remarking (*NATURE*, October 31, p. 660) upon the recent Harveian Oration by Sir Frederick Mott, has failed to appreciate the answer which "the lecturer himself gave and on which he laid great stress," to the question: What ontogenetic event coincides with the maturity at birth of the cells of Leydig? Dr. Golla then proceeds to quote at some length from the address. "Seeing that the male sexual hormones are active for probably more than six months in prenatal and post-natal periods, it follows that this influence has been operating on all the somatic cells, including the nervous system, during this time. And, if there be an elective storage of the sexual hormone in the nervous system, as Steinach's experiments indicate, then a masculine behaviouristic tendency may thus early be engraven upon the nervous system. Moreover, by the sensitising influence of the testicular hormone, the primary male characters are thus early made dominant in all the bi-sexual somatic cells." A reference to Lillie's experiments and the pathology of sexual hypoplasia follows. What our correspondent commented upon was the ambiguity of Sir Frederick Mott's terminology and the looseness of his argument. To the term "ontogeny," morphologists attach a precise meaning which can scarcely be identified with a "behaviouristic tendency," masculine or feminine. A few showy experiments do not set aside the fact which a rapidly increasing morphological literature is forcing upon our notice, that knowledge of the interstitial cells of the ovary and testis is fragmentary and conflicting. "Great stress" is a poor substitute for amply substantiated fact.

THE situation in China continues to attract a considerable amount of attention and a number of articles in the November reviews deal with various aspects of the subject. Among them Mr. George W. Keeton's study of the psychology of the Chinese student in the *Nineteenth Century and After* may serve to dispel a number of popular delusions on the characteristics of the race. At the same time, the author places his finger on perhaps the most important differences between the student of the west and of the east when he emphasises the Chinese student's lack of intellectual initiative and his proneness to memorise rather than reason—a characteristic in which the Chinese does not stand alone among eastern peoples. Another article in the same review, on the anti-Christian movement, by the Rev. A. Churwin, is also necessarily much concerned with the student as being practically the only articulate class in present-day China. Mr. Churwin shows that although much of the anti-Christian propagandist output is crude and, in so far as it is inspired by Soviet Russia, anti-religious, it is not so much the product of intolerance

as of an attitude based on a patriotic belief in Chinese culture with its long and creditable history of achievement. Against this is opposed a Christianity which, to the Chinese mind, represents in its past history and present performance an agency bringing interference with Chinese culture and ideals, western imperialism, and exploitation. This opinion is strengthened when the Chinese review the history of Christianity in the west, their judgment in this matter being strongly coloured by the critical point of view adopted by Mr. Bertrand Russell in his lectures delivered in 1922.

INTERESTING sidelights are thrown on the influences at work in present-day India by an article on "Orthodox Hindu Women," by Cornelia Sorabji, which appears in the *Empire Review* for November. The author gives a sympathetic account of the training of the Hindu girl with its insistence on the importance of caste and of marriage in the life of a woman. The resulting orientation of the female mind is entirely in the direction of the absolute acceptance of the complete subordination of the purpose of womanhood to the well-being of the soul of her husband after death and of the souls of his male forebears. This leads on one hand to the status of the wife being made dependent on the birth of sons who may inherit and thus carry on the cult, on the other hand, to the devotion of the widow, since the suppression of *suttee*, to ceremonial observances for the benefit of her late husband. The broader significance of this mental attitude is its indication of the almost complete preoccupation of the orthodox who form the majority of the Hindu population with religious rather than political matters. The position of "progressives" in these matters is delusive. The door has closed behind them; for the bulk of the population religion is still the dominant factor, and not negligible, as might be thought from a superficial view based upon the departure of the Progressives from certain observances, such as that by which the age of marriage has been raised. The successful suppression of a custom so fundamental psychologically as *suttee* is an indication of what has been possible in the past by the exercise of tact and informed judgment rather than force. Sympathetic knowledge of Hindu orthodox psychology is no less essential in dealing with the situation to-day, though this seems in danger of being overlooked.

THE November issue of *Scribner's Magazine* opens with a well-reasoned and temperate statement of the position of the American man of science in the evolutionist controversy by Prof. E. G. Conklin, who holds the chair of biology in Princeton University. His conclusions that the universality of natural law has not destroyed faith in God, that science leaves us faith in the worth and dignity of man, and that science gives us hope for the future, together with the arguments which lead up to these conclusions, are, in the main, such as will be familiar to those who have traced the development of thought on this subject in Great Britain. To English readers, however, the chief interest of Prof. Conklin's article lies in the exposition, thoroughly fair-minded, of the Fundamental point of view and the causes which have

strengthened this obscurantist movement in the United States. Among these causes, one of the most potent is undoubtedly the fact that the name of science has been taken in vain in recent years to justify license masquerading as freedom of development, moral laxity, and other social changes of an undesirable character, in a way that has brought the true spirit of scientific inquiry into disrepute with the uninstructed and narrower section of the population.

THE Cast Iron Research Association has now entered on the fifth year of its existence, and the report on its fourth year's working has just been published. The Association has a small central laboratory in Birmingham, but most of its investigators work in university or other public laboratories, or in the foundries of some of the component firms, often dividing their time between the foundry and the laboratory as the nature of the experiments demands. The programme of researches in hand is an interesting one, and although the record of definite scientific results is small in comparison with that of some other associations, this is largely to be accounted for by the fact that the industry formerly gave little attention to research, whilst problems of immediate practical importance were pressing for solution, and engaged the first efforts of the new body. Useful help has been given to the industry, and the investigators are now in a position to undertake more definitely scientific work. The determination of the ternary equilibrium diagrams which cover the range of composition of the cast irons has been begun at the National Physical Laboratory, and the results should assist materially in the control of the structure of cast iron. Reports on the progress of foundry methods in Germany have been issued to members, and the Association's Bulletins, containing full abstracts of technical literature and occasional longer articles on the theory and practice of foundry work, furnish another reason why it should receive the support of the industry.

AT the International Conference on Sleeping Sickness held in London during May last, it was unanimously resolved by the delegates to recommend to the Council of the League of Nations and to their respective governments to form a small international commission for the investigation of sleeping sickness in Africa (NATURE, June 27, p. 985). It was estimated that the expenses of such a commission would be about 10,000*l.*, and contributions were to be invited from the respective governments, the Health Organisation of the League of Nations, and scientific research institutions of certain countries. It was proposed to pursue investigations in Uganda and the regions adjacent to Lake Victoria, and the laboratories at Entebbe have been placed at the disposal of the commission. We now learn from the Geneva correspondent of the *Times* that the British Government has informed the Secretary-General of the League of Nations that it is ready to contribute a sum not exceeding 3050*l.* to the general expenses of the commission. The Belgian Government has already put at the disposal of the commission a sum of 100,000 francs, the Spanish Government 5000 pesetas,

and France the sum of 50,000 francs in the name of the administration of French Equatorial Africa and the French Cameroons.

CONSIDERABLE interest has been aroused by the announcement in the *Observer* of Sunday, November 22, of the discovery by Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology, Pasadena, of "ultra" X-rays of great penetrating power. It will be remembered that Dr. Millikan gave a series of three lectures at University College, London, in June 1924, and an abstract of the lectures, prepared by Dr. Millikan himself, was printed in our issue of July 26, 1924, p. 141, under the title of "Atoms and Ethereal Radiations." The last of the lectures dealt with "The Penetrating Radiations of the Upper Air" and it would seem that the recent announcement refers to a continuation of the work described in this lecture. In conjunction with Mr. I. S. Bowen and Dr. Russel Otis, measurements were made of the ionisation of the upper air by means of sounding balloons, during aeroplane flights and finally on top of Pike's Peak (14,100 ft) in Colorado. The conclusion reached from the latter experiments was that the whole of the radiation measured in the closed vessel used was of local origin and that "there can exist no such penetrating radiation" of cosmic origin as had been suggested by Kolhörster's work on the ionisation of the atmosphere. Dr. Millikan's new results are referred to as showing the existence of radiation of wave-lengths shorter than the γ -rays and capable of penetrating 6 ft. of lead. The publication of his results will be awaited with great interest.

IN consequence of the death of H. M. Queen Alexandra, the anniversary dinner of the Royal Society on November 30 has been cancelled.

THE eighth annual Streatfeild memorial lecture will be delivered at the Finsbury Technical College, Leonard Street, E.C.2, at 4 o'clock on Thursday, December 3, by Mr. F. H. Carr. The subject will be "The Scientific Basis of Industry."

THE second Röntgen Award of the Röntgen Society has been made to Dr. Robert Knox for his paper entitled "The investigation of the movements of the heart by the use of the slit diaphragm and the moving film," which he read before the Society during the course of the past session.

THE Council of the Royal Meteorological Society has awarded the Symons Gold Medal for 1926 to Lieut.-Col. Ernest Gold, assistant director of the Meteorological Office. The medal is awarded for distinguished work in connexion with meteorological science, and will be presented at the annual general meeting on January 20.

MR. L. C. M. S. AMERY, Secretary for Dominion Affairs and the Colonies, stated in the House of Commons on November 23 that the Governments of the East African Territories are prepared to grant sufficient funds to enable the Amani Research Institute in Tanganyika Territory to be reopened. The

necessary capital expenditure in this connexion can be found from the proposed guaranteed loan, for which a Bill will in due course be laid before Parliament. His Majesty's Government is, he said, fully alive to the importance of Amani for the future development of East Africa.

THE July number of the *Australian Museum Magazine* urges the need for additional building. The exhibition galleries are congested, the lecture-room should be doubled in size to accommodate all who desire to attend, and there is an entire lack of space for research students. It is sixteen years since additions were made to the building, and during that time the population of Sydney has increased from 600,000 to more than a million. To judge from this most attractive magazine, the Australian Museum is appealing on the best lines to the intelligent lay public of the Commonwealth, and it thoroughly deserves public support.

Messrs. W. Heffer and Sons, Ltd. (Cambridge), have in the press "The Nature of Tumour Formation," by Dr. G. W. Nicholson. The work embodies the Erasmus Wilson lectures of 1925, and seeks to

correlate the knowledge of the cellular changes which result in tumour formation with the established facts of biology and physiology, and to show that, although the etiology of tumours is still obscure, there is evidence that it is to be sought for in extrinsic causes.

Messrs. George Allen and Unwin, Ltd., have in the press "University Reform in London," by T. Lloyd Humberstone, giving an account of the establishment of the university and of the controversies which preceded its reconstruction as a teaching university in 1900. It will deal with current questions of university politics, including the reconstitution of the Senate, the policy of incorporating colleges in the University, and the site question. The work has an introduction by Mr. H. G. Wells.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned—A principal for Rutherford Technical College—Director of Education, Education Office, Newcastle-upon-Tyne (December 12). Junior scientific assistants in the Engine Research Section, Royal Aircraft Establishment—Superintendent, Royal Aircraft Establishment, South Farnborough (December 19).

Our Astronomical Column.

THE DETONATING FIREBALL OF SUNDAY, NOVEMBER 15.—A splendid fireball which gave a vivid illumination and, a few minutes later, a thunder-like detonation, was seen on the early morning of November 15 at 2^h 40^m. It was observed from many places in the eastern counties, and several descriptions came from London and its suburbs. At Caterham, Surrey, it left a brilliant train of sparks, and a loud report as of an explosion was heard shortly afterwards. At Bletchingley the object threw a strong light through a green curtain, and the moving shadows of the window frame showed the direction of the flight to be from S.W. to N.E. At London, E.C., the duration of the object was estimated as 3 seconds, and the interval between the outburst of light and the thunder-like sounds was the same (3 minutes) as at several other places. A resident near Uxbridge, Bucks., noticed the brilliant light through his window-blind and the noise, as of a distant explosion, 2½ minutes later. At some places houses were shaken and birds and animals much startled by the vibration and suddenness of the visitation, which might have been mistaken for an earthquake had not the light of the blazing meteorite proved its real character.

It was thought that the object was one of the Leonids, as the date conforms with that of this shower's return, but the direction of its motion from the S.W. proves that it belonged to some other stream than that of Leo, the latter constellation being in the east by south at the time of the meteor's appearance. It was a fine Taurid and a member of a system which annually supplies us with some brilliant detonating meteors between about November 15 and 25. The observations already to hand are not sufficiently precise to enable the real path of the fireball to be accurately determined, but its height was approximately from 62 to 30 miles over Hampshire and across the northern limits of Surrey and southern boundaries of Middlesex. The velocity was about 17 miles per second, and the detonations seem to have occurred over the neighbourhood of Houndslow.

TWO NEW COMETS.—Comet 1925 *j* was discovered by Prof. Van Biesbroeck at the Yerkes Observatory on November 17, at 11^h 31.9^m Univ. T., in R.A.

11^h 56^m 32.6^s, N. Decl. 34° 55' 8"; magnitude 8. The news was circulated in London by the British Broadcasting Company the following evening, and Dr. W. H. Steavenson found the comet the same night as a result of sweeping in Canes Venatici, which was the only clue to the position given by the B.B.C. His position was Nov. 18^d 2^h 46.6^m Univ. T., R.A. 11^h 57^m 2.70^s, N. Decl. 34° 41' 51.2". Both positions are for the equinox of 1925 0. The deduced daily motion is +47.4^s in R.A., -20.91' in Decl.

Dr. Steavenson stated that there was a nucleus of magnitude 11, and that the coma had a parabolic outline, being extended in position angle 310°. Clouds have prevented further observations in England, and none has been received from abroad, so material for the orbit is still lacking. Assuming uniform motion, the position on the morning of November 28 will be R.A. 12^h 5^m, N. Decl. 31° 13'.

Comet 1925 *k* is of magnitude 7 or 8, and was first found by Mr. Peltier, of Delphos, Ohio; Nov. 14^d 0^h 12^m Univ. T., in R.A. 15^h 25^m 0^s, N. Decl. 44° 0'.

Mr. Wilk found it independently in Poland; Nov. 19^d 17^h 10.0^m U.T., in R.A. 17^h 18^m 28^s, N. Decl. 33° 4'. It was apparently observed the following night at Cracow, as Prof. Banachiewicz telegraphed that the daily motion was +14^m 24^s, South 2° 27'. A further observation by Herren-Guthnick and Prager has since been received: Nov. 18^d 17^h 42.6^m Univ. T., R.A. 17^h 1^m 37^s, N. Decl. 35° 28' 20"; daily motion +17^m 20^s, South 2° 30'. From these data the following very rough orbit has been deduced, the elements being referred to the equator, not the ecliptic.

T 1925 Dec. 4.29 U.T.			
ω'	124°	49'	} 1925.0
Ω'	132	25	
i'	128	56	
log q	9 8960.		

There are now ten comets observed, the perihelion passage of which lies in 1925, thus equalling the record of 1898. If the perihelion passage of 1925 *j* lies in 1925, the present year beats all previous records.

Research Items.

THE ANCIENT INHABITANTS OF CALIFORNIA.—Mr. A. L. Kroeber's long-expected study of the Indians of California is now published as Bull. 78 of the Bureau of American Ethnology. It contains a detailed study of some fifty tribes. In the concluding chapters Mr. Kroeber gives some attention to ethnological questions of a broader character. Of these the one of most general interest deals with the archæology of California. The most important sources of information bearing upon the early inhabitants are the shell mounds found in several parts of the State, but investigated with most profit in the Santa Barbara area and San Francisco Bay. The antiquity of the mounds has been calculated in various ways, such as the extent to which they have been submerged by subsidence of the shore, the rate of deposit on the basis of an assumed population, the cubic contents of the mound, and the quantity of shell or wood ash mixed with the other material. These concur in pointing to an antiquity of about 3000 years for the first settlers. In cultural areas the subdivisions are constant. It is evident that the culture of the general Californian area was formed a long time ago and has remained constant ever since. During the whole shell mound period the culture remained identical in implements and utensils, in food, and in religion, the last being indicated by the charms found throughout the strata of the mounds. This permanence of Californian culture is of more than local interest. It contrasts with almost every other area in the world, while even in North America, in the Atlantic, and Mississippi regions, decisive evidence has been found of two, or several, distinct cultures in each area.

IMPLEMENTS OF THE EXTINCT ADELAIDE TRIBE.—In *Man* for November, Dr. H. Basedow discusses the purpose of certain unrecorded stone implements from South Australia to which both he and Dr. T. D. Campbell, independently, have directed attention recently. Specimens have been found at Port Noarlunga, Normanville, and Woodville, west of Adelaide. They are of blue, brown, or banded clay-slate, in general form a flat segment approximately equal to or greater than a half circle. The edge representing the chord is either straight or notched, and sharpened. Dr. Campbell suggests that they may be sacred objects akin to the stone "churinga" of Central Australia, partly on the ground of form, partly because they show certain incised markings and traces of red ochre. Dr. Basedow, however, considers that the markings are due to scratching in the making, and thinks the implements are scrapers. He relies upon information obtained from an old native of the Murray River. The tribes in the area in which these implements are principally found, the southern coast and Rapid Bay, served as a connecting link between the natives of Adelaide and the Murray River. The implement must therefore have been known to all the tribes between those two areas. According to his informant, the implements were used exclusively for scraping fat and fleshy tissue from the opossum skin used for rugs. The skin was laid over a cylindrical rod held vertically and drawn tight, the convex edge of the scraper being laid on the skin and used in a downward-direction. The advantage of the concave notch for this purpose is obvious.

ETHNOLOGY OF NORTHERN AFRICA.—Some interesting and suggestive conclusions relating to the ethnology of North Africa were put forward by Mr. Francis Rodd in a paper on "The Origin of the Tuareg" read at the Royal Geographical Society on November 16. There are among the indigenous peoples of North

Africa—for whom the name Libyan, first used by Herodotus, is preferable to that of Berber—certain nomads inhabiting the Sahara, some of whom are known by the Arab name of Tuareg. Of this race there is little known that is authoritative. They live principally by means of and on camels. Of their numerous peculiarities the best known are their intractable character, the veiled faces of the men, and the freedom of their women. Although Moslems, they retain matriarchal customs from which good Moslems would be averse. The usual statement that racially they are Berbers or Libyans conveys little. Three physical types can be distinguished among the Libyans: (i.) a tall dolichocephalic type with narrow face; (ii.) a short dolichocephalic type with broad face, obviously related to Cro-Magnon man; and (iii.) a short brachycephalic type with short, broad face. The Tuareg belong to the first of these. No nomads occur in the second and third groups, this mode of life apparently being a racial characteristic. The second type is probably that which is the prototype of the race responsible for the agricultural people who predominantly populate North Africa. Egyptian records of the invasion of the Nile Valley by the Libyans in the eighteenth and nineteenth Dynasties suggest that the Tuareg are to be identified with the Temahu and Tehenu of those invasions. The Tuareg type displays certain Nordic characters which may therefore be tentatively explained by attributing to them a northern origin due to the racial movements which took place at the beginning either of the Bronze Age or of the Iron Age, and of which the invasions of the Nile Valley from the west at various periods were a result.

THE STRUCTURE OF PROTOPLASM.—Prof. Josef Spek of Heidelberg summarises briefly in *Die Naturwissenschaften* for October 30 the change in the attitude of the investigator towards this problem. No longer is there an attempt to find, with improved microscopic methods, an ultimate unit of living matter, or to resolve all protoplasmic structure upon a "foam" structure, such as advocated by Bütschli. Microdissection experiments, experiments with centrifugal force, etc., have led to the recognition that the plasma may vary in consistency from fluid to solid gel, and that both types may coexist in different parts of the same cell. Spek reviews the results obtained by studies of transparent infusoria in the dark field illumination, when these organisms are subjected to various external solutions, and shows that for many protoplasmic masses, but not all examined, the evidence supports the presence of an emulsion of very fine dispersed watery droplets in another continuous phase. He illustrates the manner in which these droplets can be brought readily within the limits of vision by treatment with salts near that end of the "lyophile" series which indicates great activity in producing precipitation. Spek shows that in emulsions of various immiscible liquids a similar microscopic dispersion of one phase within the other takes place, e.g. of glycerin in olive oil, water in aniline, etc. The physical chemistry of such a distribution is not clear; either one substance disperses through the other by methods that are non-molecular but in the form of particles that are colloidal and even of microscopic visibility, or it dissolves in the dispersing medium and afterwards comes again out of solution.

THE SARGASSO SEA.—In the *Geographical Journal* for November, Capt. C. C. Dixon gives the results of many observations on the amount, extent, and condition of weed in the Sargasso Sea at various seasons.

He shows on a map that the extent of the Sea is approximately between lat. 15° and 40° N., and between the West Indies and long. 35° W. Within this area weed occurs. By adopting a scale from 1 to 10 he has been able to map the distribution of weed, while on several occasions he conducted experiments to determine the amount of weed per square nautical mile. From this he estimates that in the whole area of the Sargasso Sea there are about twenty million tons of weed. If the supply comes from the Caribbean Sea, as seems probable, it must come mainly through the Straits of Florida, where estimates show that about five million tons pass in a year. These estimates would suggest that the weed in the Sargasso Sea cannot all die and be replaced in less than four years. The state of the weed appears to be a question of locality rather than season or sea temperature, for most of the dead weed is found in the warmer waters, while the freshest weed is on the north-western side of the Sea nearest to the source of supply. Capt. Dixon contends that from past records there is evidence that the weed-strewn area is decreasing in extent or changing its position, but the evidence for this conclusion is somewhat slender.

ARGON IN LIVING CELLS—The presence of argon in living cells has been shown by the experiments of Amé Pictet, W. Scherrer, and L. Helfer, described in the *Compte rendu des Séances de la Société de Physique et d'Histoire Naturelle de Genève*, vol. 42, No. 2, 1925. The authors proved that the small quantity of argon they found in the fermentation of glucose came from the yeast. It was roughly estimated by distillation in a vacuum and by passing the gases over heated copper oxide. The nitrogen evolved contained about 3 c.c. of argon for 10 grams of yeast. Bullock's blood and sheep's brains on similar treatment yielded slightly higher proportions of argon. The exact origin of this argon has yet to be found.

VEGETATIVE PROPAGATION OF RUBBER.—The *Malayan Agricultural Journal*, September 1925, reproduces fully Dr. Heusser's important report upon the experimental tapping of Hevea budded trees. Dr. Heusser's work has now progressed so far as to lead him to recommend firmly the budding from selected stock instead of the planting of seedlings. If budding methods prove successful, this advice almost inevitably follows, as it permits of a plantation in which a few "clones," that is, trees all propagated vegetatively from one common stock, give a uniform grade of produce, instead of the variable yield and quality obtained from a plantation consisting of seedlings. Thus gradually tropical agriculture may be expected to follow along the lines which cultivation has followed in the Old World and in North America.

ENTOMOLOGICAL ANALYSES OF TREES—In the *Bulletin of Entomological Research* for October 1925, Dr. Ivar Tragårdh, of the Swedish Forest Experiment Station, has an interesting paper on this subject. The forest entomologist, examining dead or dying trees, is confronted with the problem of the species responsible for the attack, and why particular trees should suffer while their neighbours of the same species are left untouched. These points are vital in that if we know exactly what type of tree is liable to be attacked by a certain insect, it opens up the possibility of prevention by the aid of improved forest management. In order to obtain the requisite information, Dr. Tragårdh is of opinion that two things at least are necessary: first, an extensive series of analyses of felled dead or dying trees, recording the ways in which different species of insects succeed one another, the nature and extent of the injuries they occasion,

and the position of such species in the tree; secondly, experimental plots for the purpose of watching the attacks from their initiation. By combining the results obtained by these two methods, with a thorough analyses of ecological factors, it is hoped that we shall eventually be in a position to formulate better-founded opinions respecting the activities of injurious forest insects.

FIBRE FROM PINEAPPLE LEAVES—Messrs. R. O. Bishop and E. A. Curtler have some interesting notes upon the experience of the Department of Agriculture, Malay States, in preparing fibre from the leaves of *Ananas sativus*, of which some 20 tons were shipped from an $8\frac{1}{2}$ -acre plantation in which pineapples were grown for the canneries (*Malayan Journal of Agriculture*, September 1925). So far as could be judged, this amount of leaf stripping had no appreciable effect upon the plantation. The 20 tons of fresh leaves only gave some 4 cwt. of fibre, but the fibre appears to be of high grade, fine in staple and lustrous, and with a fine silky texture. The leaf was stripped in a raspador machine designed to treat sisal, and the fibre required further washing and scraping with a blunt knife. Its commercial utilisation would depend upon a more suitably designed machine, but in view of the comparatively small leaves with low yield of fibre, the authors conclude that whilst fibre can be obtained from the leaves as a by-product in canning the fruits, it is extremely doubtful whether the process would be profitable commercially.

PERMIAN INSECTS—Dr. R. J. Tillyard continues his work on the Permian insects of Kansas (*Amer. Journ. Sci.*, 9, 1925, p. 328, and 10, 1925, p. 41) and Australia (*Proc. Linn. Soc. N.S. Wales*, 49, 1924, p. 429). The earliest remains of beetles hitherto known are of Triassic age. In the Upper Permian of Belmont, New South Wales, numerous elytra of beetles have now been discovered, and include a form (*Protocoleus*) which differs in important respects from all known Coleoptera, for this genus a new order (*Protocoleoptera*) is proposed and is regarded as the forerunner of the Coleoptera, and as intermediate between the Carboniferous *Protoblattoidea* and the true Coleoptera.

SWEDISH TRILOBITES.—A monographic account of the trilobites of the Leptæna limestone of Dalarne is given by Miss Elsa Warburg (*Bull. Geol. Inst. Upsala*, 17, 1925). The fauna is a rich one, and includes about 120 species or varieties of trilobites. It is of interest to British geologists from its resemblance to the Upper Ordovician faunas of Keisley and Kildare. The Leptæna Limestone is a reef rock found in the neighbourhood of Lake Siljan. The author concludes that it was formed during two periods separated by a time during which no reef building took place; so that there is a Lower and an Upper Leptæna Limestone, and it is the latter which seems to represent the limestones of Keisley and Kildare. The systematic part of this memoir is preceded by a discussion of the morphology, classification, and affinities of trilobites.

TILTING OF THE GROUND AT THE HAWAIIAN VOLCANO OBSERVATORY (KILAUEA).—Mr. R. H. Finch has contributed a preliminary note on this subject to the *Volcano Letter* (October 8, No. 41) of the Hawaiian Volcano Research Association. In addition to the diurnal and seasonal tilts which follow closely the diurnal and seasonal temperature changes, there is a much more distinctly marked tilt in connexion with volcanic activity. From 1913 to 1919-20, there was a gradual rise of 600 feet in the mean lava level. This was accompanied by a gradual swelling of the mountain-top as shown by the north-east tilt of

the observatory seismographs. The re-levelling of the ground from the sea-level showed that the height of the observatory had increased by more than a foot between 1912 and 1921. From 1919-20 to 1924, the lava column gradually sank, and, with this sinking, there was a rapid south-west tilt of as much as $1' 32''$ during the three years 1922-24. Re-levelling from the observatory to two points near Halemaumau showed that one point had sunk five feet and the other nine with respect to the observatory, which itself had undoubtedly sunk several inches.

ECHO SOUNDING IN THE PACIFIC OCEAN.—The method of echo sounding has been illustrated by the voyage of the U.S. destroyer *Stewart* across the Atlantic, through the Mediterranean, across the Indian Ocean and into the Pacific. Profiles of depths have been published by the Hydrographic Office of the Navy Department at Washington. When steaming on a north-westerly course between Manila and Hongkong, a rapid decrease of depth from 2140 to 300 fathoms was recorded at five-minute intervals over a distance of nine miles. After passing the bank into deeper water again, the course was turned sharply to south, then east, then north-west again so as to obtain further soundings. It is evident that the method of echo sounding is of very great value for detecting and surveying hitherto unsuspected shallows. In the Pacific and Indian Oceans it is of further interest in connexion with Darwin's theory of upgrowing coral reefs on subsiding foundations. Fuller details and a map of the Stewart Bank in lat. $17^{\circ} 16' N.$, long. $118^{\circ} 34' E.$, are given in an article by Prof. W. M. Davis, of Harvard, in *Science* for October 30.

WEATHER IN THE WEST INDIES.—The annual summary of the weather for 1924 by Mr. Oliver L. Fassig, meteorologist in charge of the West Indies and Caribbean Service, in co-operation with the Weather Bureau of the U.S. Department of Agriculture, has recently been issued. For the first time during the last four years, since the establishment of the West Indies Climatological Service, the total annual rainfall for the section as a whole was above the normal; the average rainfall was 66.67 in., or 7.39 in. above the normal. The result is based upon reports from more than 500 stations. The rainfall on the whole was well distributed through the year. The areas of lightest rains, about 30 in., are the Bahamas and Turks Islands in the north, and the Islands of Curaçao, Aruba, and Bonaire off the coast of Venezuela. The areas of heaviest precipitation are the Central American States from Costa Rica to Guatemala, with annual amounts varying from 118 in. to 147 in. The number of days with appreciable rainfall varied from 64 in the Bahamas to 212 in Nicaragua. The average temperature in 1924 for the entire section was $78^{\circ} 7' F.$ or $0^{\circ} 9'$ above the normal; temperatures are said to have been above the normal for every month of the year. Two hurricanes passed over the Lesser Antilles during August; the storm of August 27-31 was one of the most destructive in recent years, doing much damage along its path, while in the Virgin Islands the estimated wind velocity was more than 100 miles per hour during the night of August 28-29.

ATOMIC STRUCTURE.—The November issue of the *Philosophical Magazine* contains a paper by Sir E. Rutherford and Dr. J. Chadwick describing their experiments on the scattering of α -particles by light elements like aluminium and magnesium and by heavy elements like gold and uranium. The velocities of the α -particles were varied by interposing sheets of

mica in the paths of the rays, and the number of particles scattered at an average angle of 135° was counted. No divergence from the scattering deduced on the assumption that the inverse square law of repulsion holds within the atom could be detected in the cases of gold, platinum, silver, copper, and uranium, but in aluminium and magnesium the number scattered in the observed direction for speeds of the α -particles, giving them ranges of about 5 cm. in air, was considerably less. This decrease was confirmed by measurements of the scattering at 90° . The authors consider that these facts point to the central nuclei in the aluminium and magnesium atoms being surrounded by a shell of negative charges beyond which is a further shell of positive charges. α -particles which penetrate the outer shell are repelled by a field due to the difference of the nuclear positive and the negative shell charges, and are therefore less scattered than those which do not approach the centre of the atom so closely.

A NEW WESTON CELL.—The preparation of a reproducible Weston cell with a low temperature coefficient is described by W. C. Vosburgh in the *Journal of the American Chemical Society* for October 1925. The reduction in the temperature coefficient is effected by introducing tin, lead, or bismuth into the cadmium amalgam electrode. The presence of tin caused an increase from 1.01805 volt to 1.01901 volt at 25° , while the temperature coefficient was reduced to about two-fifths that of the Weston cell. Lead gave a cell of electromotive force 1.01918 volt at 25° , but the temperature coefficient was greater than that of the cell containing tin. The introduction of bismuth changed the electromotive force of the Weston cell to 1.01976 volt at 25° , the temperature coefficient being positive and equal to the negative coefficient of the cadmium-tin amalgam electrode. The values of the electromotive force were constant over the periods of time during which they were examined.

THE SEPARATION OF SILVER FROM HALOGEN COMPOUNDS BY STRONG ILLUMINATION.—Experiments to show that silver is separated from its halogen compounds by light, without the use of a photographic developer, are described by P. P. Koch and H. Vogler in the *Annalen der Physik* for September. Most of the work was done with silver bromide, which was used either in a fine powder or in a gelatin film shaved off from a soaked photographic plate, a number of these films were piled on one another to make a small slab to be placed in the Debye-Scherrer camera. When the preparation was made in red light the ring system, obtained by passing X-rays through it on to a photographic film, showed in both cases the simple cubic lattice of silver bromide as described by Wilsey, with lattice constant $a = 2.89 \times 10^{-8}$ cm. When the silver bromide was exposed to strong light before being placed in the camera, the ring system of silver was superposed on that of silver bromide, and when the silver bromide was removed from these preparations by an acid fixing bath, the ring system of silver alone was produced. The dimensions of the minute silver crystals, as determined by the breadth of the rings, were more than $24 \text{ \AA.U.}$, so that it appears that the silver crystallises round a comparatively small number of "buds," formed at the commencement of the illumination. It is shown that 31 per cent. of the silver in the plate was separated out by strong illumination. The X-rays used did not separate an appreciable quantity of silver from silver bromide, but this was not true of silver chloride. No silver was separated from silver iodide by the action of light.

The Chemistry of Painting.¹

IT is noteworthy that the modern oil picture is apt to darken, or lower in tone, while, on the other hand, not only the oil pictures of the fifteenth century, but also in many cases the oil pictures of later schools, such as the Dutch school, have altered little from the day they left the studio. It must not be supposed that all modern pictures suffer equally from this defect; some artists have successfully avoided it, but in other cases the lowering of tone has been very serious.

An examination of the information to be obtained from old manuscripts describing painting methods from the twelfth century up to the time of Vasari is in favour of the view not only that oil was used as a medium throughout this period,—at any rate in the north,—but also that there is no suggestion of any special mystery in the nature of the medium itself. The oils used were linseed and walnut, and, later on, poppy; and the methods of preparation and purification did not differ widely from those used to-day, but when exactly repeated, they do not yield an oil which enables the difficulties of the modern painter to be overcome.

When we turn from the oil to the pigments, we find that many of the pigments used to-day are those which have been used throughout the history of painting, and many modern pigments are undoubtedly preferable to those used in earlier times, and are more permanent. We are driven to the conclusion that the troubles of the modern artist are due not to his materials, but his methods, and are, moreover, due not to his pigments, but to the medium in which the pigments are ground, namely, oil. It therefore becomes necessary to study carefully, not so much the chemical as the optical properties of oil, and the optical principles underlying oil-painting.

Pigments can be regarded as if they are little particles of coloured glass, and their apparent opacity is due to their high refractive index. It therefore follows that when ground and mixed with a medium like oil, which has a fairly high refractive index, their so-called opacity will depend upon their having a much higher refractive index than oil.

The oil painter then must know the comparative opacity of his pigments, and such a table has been prepared by Prof. Laurie, by grinding the pigments in liquids of higher and higher refractive index until they proved transparent by transmitted light under a $\frac{1}{4}$ -in. objective. White lead, for example, ground in bromonaphthalin is found to consist of transparent doubly refractive crystals, thus confirming the researches of Green under high pressure. In this table the pigments are arranged not only in order of opacity, but also according to their position in the spectrum, from red

to blue. In order to understand the reason for that double grouping it is necessary to consider the properties of the linseed oil film. The dry film in oil in course of time becomes yellow, and also gradually increases in refractive index. The yellowing of the oil will obviously affect pigments at the blue and green end of the spectrum more than those at the red and yellow end; and the slow rise in refractive index will make the more transparent pigments deeper and more translucent in tone than the more opaque.

The pigments of the artist's palette can be divided roughly into two groups—those to be used for solid painting and those to be used for glazing. For example, cobalt blue is in itself a permanent pigment, but it consists of transparent blue particles; consequently the light penetrates deeply into a mixture of cobalt blue and oil, and if such a mixture be painted on thickly, the yellowing of the oil will finally result in cutting out the whole of the reflected spectrum, the mixture of oil and cobalt blue therefore becoming black.

Early methods of oil-painting as revealed by certain unfinished pictures—such as the two unfinished Michael Angelos in the National Gallery—illustrate these principles. Starting with a white gesso, the light and shade were put in in tempera, the white gesso being kept for the whites, and in some cases even colour was laid on in tempera—the modelling, for example, of a robe being done in bright red on the white gesso. The egg or size medium, being of low refractive index, gave the full value to the brilliancy of the pigments, and also has proved, under the test of time, not to change. A thin glazing of transparent oil colour on this foundation, while suffering degradation from the yellowing of the oil, would increase in brilliancy from the rise in refractive index of the oil making the pigment more transparent, and allowing more light to be reflected from the tempera pigment below.

At a later stage in the history of oil-painting, while the preliminary painting in tempera was abandoned, the white gesso surface was still used, and the high lights of white lead and oil painted as thinly as possible, so as to ensure reflection from below. With Rubens the custom of transparent shadows and solid lights came in, but, here again, as the pictures of the Dutch school show, the practice was still continued of painting thinly on a white gesso, and where white lead was used for a solid light, it was ground very stiffly with a minimum of oil.

These pictures are of great interest, as showing how far the ancient methods can be adapted to the requirements of the modern artist, as has been shown by Mr. Sims, R.A., whose portraits of the King and Prof. Hay are interesting examples of painting in egg alone, and doing the first painting in egg and finishing in oil.

¹ From lectures delivered by Prof. A. P. Laurie to the students of the Royal Academy of Arts, London, on Wednesday, November 11, and subsequent dates.

Geological Survey in Great Britain.

THE "Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the year 1924" (H.M.S.O., price 2s. 6d.) gives proof of energy and increasing usefulness in all branches of the institution. As a result of the strengthening of the staff of late years it has become possible to carry on field-work in so many as nine districts. Branch offices have been established at Newcastle-on-Tyne, Whitehaven, Manchester, and York, and thus the work of systematic surveying has been facilitated, and a closer touch has been maintained with all parts of the kingdom than was

formerly possible. This leads to the securing of many records of temporary excavations and other works that might otherwise have been lost. The results of the year's work are presented in a volume of undoubted value, but we find in it a report by the Geological Survey Board, a report by the director, an introduction on coal-field revision by the director, and detailed reports on the Districts by the district geologists, all touching upon more or less the same subjects. Repetition under such conditions is inevitable.

In the field-work the first importance has been

attached to the 6-inch surveying of coal-fields and their surroundings, and to the revision of those which have been surveyed on that scale but have not been re-examined within the last thirty years. At the same time the information collected concerning the mineral resources of Great Britain, the value of which has been abundantly recognised, is being kept up-to-date by periodic visits of members of the staff to working mines and by maintaining contact with new developments. The information is published in the Special Reports on the Mineral Resources of Great Britain, of which it is stated that twenty-eight volumes have been issued and two more are in the press.

The Districts in which systematic surveying is in progress include the south-eastern counties. The Aldershot sheet of the 1-inch map, which has special claims as illustrating a military and residential centre, is being surveyed for the first time on the 6-inch scale. Maps and memoirs on the Hertford, Dartford, Brighton and Worthing sheets were published during the year. Inquiries relating to underground sources of water are especially numerous in this part of the country, and a close watch is kept on deep borings. The records of some recently examined appear in an appendix, with a map showing the underground limits of the Lower Greensand, one of the most important sources. The absence of this formation at Fobbing, in Essex, has been proved by a boring which entered Cambrian rocks underlying Gault at a depth of 1127 feet. In the Midland District the Flint map and memoir have been published and those relating to Wrexham are well advanced. The Birmingham and Wem sheets have been published and the memoirs written. The surveying of the Wolverhampton, Shrewsbury and Stafford sheets is in progress. In the Lancashire District revision is proceeding in the Rochdale and Manchester area. A special feature in this revision is the attempt to decipher the succession of the Millstone Grit and Lower Coal Measures by means of *Goniatites* as zone-fossils. In the Yorkshire District work in progress in the Huddersfield sheets carries on eastwards the work done in Lancashire. The explorations in the concealed Yorkshire and Nottinghamshire

coal-fields, one of the most important reserves of coal in Britain, are receiving careful attention. In the Cumberland District progress has been made in the Whitehaven and Brampton sheets. The Carlisle, Silloth and Longtown sheets with the corresponding memoir are on the point of publication. In the Northumberland and Durham District revision has been carried on in the Ford, Alnwick and Rothbury sheets and some work has been done in the Morpeth and Newcastle sheets. The Norham, Berwick and Holy Island sheets are being engraved.

In Scotland attention was centred chiefly on the lowlands and coal-fields, but, as the director points out, Highland geology has not been neglected. Six Highland memoirs were written or corrected for press, including that on the Tertiary and Post-Tertiary geology of Mull, etc., in which is described one of the most intricate regions that it has fallen to the Scottish Survey to interpret. In the Lowlands the Kilmarnock sheet is completed and the Ayr sheet well advanced. In Lanarkshire the older rocks underlying the production strata to the south of the central coal-field are being re-examined. The economic memoir on Area VI. (Bathgate, Wilsontown and Shotts) has been published, and second editions of other memoirs are in hand.

Special mention must be made of the bequest to the Geological Survey by the late Dr. Kidston of his collection of fossil plants, photographic negatives and manuscripts. The acquisition of these beautiful specimens will make the Museum one of the principal centres of systematic Carboniferous palaeobotany in the world, when it becomes possible to exhibit them. The preliminary plans for the new Museum and Survey Offices at South Kensington are now under consideration—the building will adjoin the Natural History Museum on one side and the Science Museum on the other. The two national geological collections will then be in close communication, the one biologically arranged and illustrating the evolution of forms of life on the globe, the other stratigraphically arranged and illustrating the stage in evolution attained at each successive period of the globe's history.

The Principal Botanical Garden, Leningrad.

By Prof. BORIS FEDTSCHENKO (Leningrad).

THE Botanical Garden was founded at St. Petersburg in 1713 by Peter the Great as a Druggist's Garden. In 1824 it was reconstructed into a scientific institution under the name of the "Imperial Botanical Garden," and in 1917, at the beginning of the Revolution, it was renamed "The Principal Botanical Garden of the Russian Republics."

The former activity of the Garden is well known, but it is of interest to make a brief survey of the present activity of this institution. It can be said that, on the whole, the Botanical Garden has successfully survived the difficult times of the War and of the revolution. The buildings are now nearly in the same condition as formerly, or better, since in 1924 the Garden was allowed a sum of money for the reconstruction of all the houses which had fallen partially into disrepair at the time when the coal supply was insufficient. The staff, both scientific and technical, is now no smaller than before the War; the number of principal departments of the institution is now twelve—before the War there were eight. The director of the Garden is Prof. B. Issatchenko, the well-known botanist who recently visited the great European botanical gardens.

One of the principal departments of the Garden is that for the cultivation of living plants. The large number (about twenty-four) of hot-houses and temperate houses are well stocked with many interesting tropical and subtropical plants from all parts of the world; in the rockeries and beds and in the grounds there are many cultures of herbaceous and woody plants chiefly from Northern and Central Asia, from Siberia, North America, and so on. Every year the Garden receives from correspondents a large stock of bulbs, seeds, etc., of new and interesting plants for cultivation; tropical and subtropical plants are received from other Gardens in exchange. The department of living plants is under the direction of Prof. Komarov, a well-known botanist and traveller.

The Herbarium of the Garden is the centre for the systematic and geographical exploration of the flora of Russia. The immense collections (about three million specimens) are stored in what is probably the largest Herbarium house in Europe. The building is of four stories and was built in 1913, the ground-floor being the library of the Garden. The principal work of the Herbarium at present is the

compilation of a flora of Asiatic Russia under the direction of Prof. Boris Fedtschenko, chief of the Herbarium, and some other specialists and volunteers. Local floras of Turkmenistan and south-east Russia, among others, are also being worked up. Recently much work has been done on South American plants. Herbarium specialists are preparing monographs on Tulipes, Artemisia, Tamarix, Gramineæ, Leguminosæ and many other groups of plants. Every year most of the botanists of the Herbarium staff go to the different countries of Russia and adjacent Asia for botanical and geographical studies; this year some are in Turkmenistan, Persia, and in Mongolia.

The cryptogamic department, formerly a part of the Herbarium, is now separated under the direction of A. A. Elenkin and is carrying on intensive studies upon Russian mosses, lichens, algæ, and fungi.

The geo-botanical department, under the direction of Prof. N. Kuznezov, has in hand the making of a geo-botanical map of the European part of Russia. This map is now ready on the scale of 1:2,500,000, and the staff of the geo-botanical department is working on the more detailed maps.

One of the most recent departments of the Botanical Garden is that of acclimatisation, under the direction of W. Sukatshef. The purpose of this department is to introduce into cultivation new and interesting plants from different parts of Russia and from adjoining countries. This department has special grounds for the cultures of perennial, herbaceous, and woody plants, as well as for the experimental nurseries of different varieties of fruiting trees and shrubs.

The museum of the Garden since 1891 has been under the direction of N. Monteverde; it has received very large and interesting collections in the last few years. A special section of the museum is working on the study of medicinal plants, which is of great importance for human welfare and health.

There are two departments of the Garden which deal chiefly with practical problems: one is that of seed studies, where numerous analyses of seeds and germination tests are made. Scientific studies on seeds are also carried on. Two important and interesting problems have recently been worked out: the first upon the difference between winter and summer wheat and barley, the other in distinguishing correctly between living and dead seeds.

The other department with many practical problems is that of phytopathology, in which specimens of plant diseases sent from different parts of Russia are studied, and new plant parasites are described.

The department of plant physiology is working on several physiological problems, chiefly dealing with assimilation. The department of hydrobiology is carrying on studies upon the cryptogamic plants of

the plankton of Russian rivers and lakes, particularly in the Leningrad region.

The Library of the Garden is the richest botanical one in the country, and it has a large stock of recent and back publications of the Garden for exchange.

The Garden has now three affiliated gardens: one of these is in a suburb of Leningrad, another in Omsk (Western Siberia), and the third in Vladivostok (Eastern Siberia).

The results of the scientific studies of the staff are published by the Garden in numerous botanical articles and larger works, although handicapped by the very small sums granted for publications. The principal and the oldest publication of the Garden is *Acta Horti Petropolitani*, started in 1872, now under the direction of B. Fedtschenko. This journal contains chiefly voluminous works such as those of Komarov, Fedtschenko, Roshewitz, and other botanists of the Garden. The *Bulletin* of the Garden is chiefly for the publication of short articles on all branches of botany. The *Morb: Planiarum* and the *Annals of the Department for Seed Study* are the special organs of the departments of plant pathology and of seed study.

Recently the Garden has commenced the publication of three new periodicals: *Conspectus litteraturæ botanicæ*—an abstract journal chiefly for Russian botanical literature. Without this it would be very difficult to know of all the botanical publications which are now appearing in large numbers every year in different parts of Russia. Another new publication of the Garden is *Notulæ systematicæ ex Herbario*, this contains chiefly descriptions of new species and genera from all parts of the world from the specimens in the Herbarium of the Garden. In this publication, as well as in the others, contributions are received both from the staff of the Garden and from botanists in other parts of Russia (including Ukraina, Caucasus, Turkestan, Siberia). A similar publication, *Notulæ systematicæ ex Instituto Cryptogamico*, deals with the cryptogams.

Every year the Garden sends botanical expeditions to study plants in different parts of Russia and Asia. The most important journeys have been into Central Asia, Transbaicalia, Mongolia, Persia, etc.

The facts given above show that the Botanical Garden in Leningrad is at the height of its activities in botanical study, and that excellent opportunities are afforded for solving important problems. Now, as formerly, the Garden is in correspondence with the chief botanical institutions of the world. Any question upon the flora of Russia or Russian botanical literature, or regarding botanical research in Russia, will be gladly answered from the Garden or by the present writer.

Stone-dusting Tests in England and America.

THE Safety in Mines Research Board has just issued a pamphlet¹ which will be of great interest to mining engineers both in the United States and in Great Britain. It contains the first fruits of that arrangement for co-operative research which was made last year between the U.S. Bureau of Mines and the British Safety in Mines Research Board, and is published under the joint names of the two directors of research, Mr. G. S. Rice and Prof. R. V. Wheeler.

The investigations begun in the large steel gallery at Eskmeals by the Home Office Committee on the efficacy of "stone-dusting" in preventing coal-dust

¹ Mines Department. Safety in Mines Research Board. Paper No. 13. Stone Dust as a Preventive of Coal Dust Explosions. Comparative Tests By G. S. Rice and R. V. Wheeler. Pp. 15 (London: H.M.S.O., 1925.) 3d net.

explosions were soon supplemented by the researches made in the experimental mine at Bruceton, near Pittsburgh, by the Bureau of Mines. But the results obtained at the two stations showed differences which led to the assumption that the Pittsburgh coal was much more sensitive to ignition than the Altofts Silkstone used as the standard at Eskmeals. Such an assumption rendered futile any comparison between the two sets of experiments, and the conclusions drawn in one country could not be applied; it was thought, to the conditions of the other. The first step in co-operation was taken when a consignment of Altofts Silkstone was sent to Bruceton, and a similar supply of Pittsburgh coal was received at Eskmeals. The experiments carried out at the two

stations now described show that the behaviour of the two coal-dusts is very much the same when the experimental conditions are similar; and the conclusion is drawn that the differences between the results at the two stations are due to the greater severity of the American tests. At Bruceton the experimental mine is driven into an actual coal-seam and has a cross-section of 58 square feet; the powder-charge used as the source of ignition is 4 lb.; the dust is spread on cross-beams near the roof as well as on side shelves and on the floor. At Eskmeals the original experiments were carried out in a circular steel gallery of 7½ feet diameter; the later comparison-experiments were made in a smaller steel tube 38 inches in diameter with a charge of 28 oz. of blasting-powder.

Again, in a number of experiments where small percentages of gas were present with the dust, the Americans used their natural gas containing, besides methane, some 15 per cent. of higher paraffins—ethane, propane, etc.—which ignite more readily than the pure methane derived from coal. The conditions both of ignition and of propagation were therefore more favourable at Bruceton than at Eskmeals. It is a clear gain to have established that the standard coals used at the two stations are so nearly similar that the varied experience obtained in one country can be applied, under the same working conditions, to the other.

The Data for Weather Forecasting.

METEOROLOGISTS are being urged to extend the periods covered by their forecasts,* and in a recent paper¹ Exner has worked out the correlation coefficients between contemporary monthly pressure departures at Stykkisholm (Iceland) and those of seventy other places distributed over the earth. The data handled are from 1887 to 1916, and the monthly departures of pressure and temperature for all the stations are most generously printed at length for the benefit of other workers. Their mean square values also are tabulated and briefly discussed.

Relationships in the North Atlantic had previously received considerable attention, from Exner and others, so the results in the present paper, though of the greatest value, are not in general surprising. There is a region of close positive relationship extending from Baffin's Bay to Norway, and one of negative relationship near the Azores, in winter extending from the Bermudas to Italy, with an outlying region in Japan: with places in the southern hemisphere there is little connexion.

An important feature of the paper is its hope of inauguration of a programme of calculation of which the present 840 coefficients form but a small fraction. If all were worked out, there would be more than 120,000 contemporary monthly relationships between 143 variables, 71 of pressure and 72 of temperature. But, though Exner does not suggest any extension, this would not be enough; for with many places, especially in the southern hemisphere, there are essential effects produced after six months. These non-contemporary effects are vital for forecasting, and if we were to correlate a monthly value at one place with values from seven months before to seven months after at other places, we should multiply our coefficients by 15.

There is much to be said for the plan adopted in Walker's two papers on world-weather of using quarterly values. With twenty "centres of action," the total number of coefficients, including time intervals of ± 2 , ± 1 , 0 quarters, is then 7600, and a number

¹ "Monatliche Luftdruck- und Temperaturanomalien auf der Erde: Korrelationen des Luftdrucks auf Island mit dem anderer Orte." *Sitzber. d. Akad. d. Wiss. in Wien*, Abt. IIa, 133 Bd., 7 u. 8 Hefte, 1924.

of stations may be added without a prohibitive amount of labour.

Exner's argument for dividing the year into twelve rather than four periods is that he proposes in this way to distinguish real from accidental relationships, the former being distinguished by a smooth, regular series of values during the year.² But it has not been shown that statistical criteria applied to quarterly values have failed; and as the largest of twelve errors in Exner's coefficients has a probable value of 0.35, a smooth series is as accidental as a fairly irregular one.

It is a matter of sincere congratulation that Exner's great ability is being directed to the elucidation of these questions of commercial as well as scientific importance.

* "Regelmässige Verlauf durch die zwölf Monate," *loc. cit.* p. 329

University and Educational Intelligence.

CAMBRIDGE.—Mr. J. A. Chadwick has been awarded the Arnold Gerstenberg Studentship (for moral philosophy and metaphysics). Mr. Chadwick took the Natural Sciences Tripos Pt. I. in 1923 and the Moral Sciences Tripos in 1925; he was recently elected to a fellowship at Trinity College.

A grant of 50*l.* has been made to Miss Marion F. Bridie of Birmingham to facilitate her research as to the ultimate effect of education among the mentally deficient.

LEEDS.—The West Yorkshire Coal Owners' Association has given 25,000*l.* to the appeal fund. In accepting the gift, the council of the University passed a resolution stating that the success of the University's Department of Mining is due in large measure to the co-operation of the industry, not only in the form of subscriptions, but also through assistance given on the Mining Advisory Committee, by facilities offered to students for gaining practical experience, and in other ways. The annual grants made through the Association amount to nearly 10,000*l.*, and these are to be continued at the rate of 1000*l.* a year.

The following appointments have been made:—Mr. W. Murphy to be demonstrator in experimental physiology, and Dr. Arthur Raistrick to be research assistant in geology.

LONDON.—Mr. Hilary Jenkinson has been appointed as from August 1 last to the University readership in diplomatic and English archives tenable at King's College. Mr. Jenkinson is the editor of volumes of the Surrey Archaeological Society and Surrey Record Society, and is the author of numerous works on palæography.

It has been resolved to institute an M.A. degree in geography for external students.

The following doctorates have been conferred:—*D.Sc. (Chemistry)*, Mr. J. M. Johlin (University College), for a thesis entitled "The Surface Concentration of Colloids at a Liquid-Gas Interface"; *D.Sc. (Entomology)*, Mr. H. P. Hacker, for a thesis entitled "How Oil Kills Anopheline Larvæ," and other papers.

THE effect on school-holidays and on the various branches of education in every country of a fixed date for Easter is being investigated by the League of Nations' Special Committee of Enquiry into the Reform of the Calendar. This Committee, on which the Rev. T. E. R. Phillips, Secretary of the Royal Astronomical Society, represents Great Britain, has been devoting particular attention to the question of the fixing of Easter and now wishes to conclude its general inquiry. While the need of fixing this festival

has been felt more especially in economic circles, certain replies received by the Committee seem to show that a similar desire exists in educational circles, since, if Easter be fixed, the date selected would be of great importance from the point of view of holidays, holiday courses, etc. A circular-letter has accordingly been sent to all the Governments asking them, before December 15 next, for the views of their Education Departments and other educational authorities.

THE 'Secretary' for Scotland, in consultation with the Minister of Labour, has appointed a Committee "to inquire into and advise upon the public system of education in Scotland in relation to the requirements of trade and industry, with particular reference to the adequacy of the arrangements for enabling young persons to enter into and retain suitable employment." The Committee will be composed of the Right Hon. Lord Salvesen (chairman), Dr. R. S. Allan, Prof. T. Hudson Beare, Mrs. Charles Douglas, Mr. James Elder, Mr. William Lorimer, and Mr. D. J. Macdonald. Mr. James Clark, H.M. Inspector of Schools, and Mr. W. H. Lowe-Watson, Ministry of Labour, will be joint secretaries. All communications should be addressed to the joint secretaries at the Divisional Office, Ministry of Labour, 44 Drumsheugh Gardens, Edinburgh.

A THIRD series of "Methods and Problems of Medical Education" has been issued by the Division of Medical Education of the Rockefeller Foundation. These publications contain brief descriptions of clinics, laboratories, and methods of teaching in different parts of the world. The articles are not copyright, and permission to reprint or otherwise to utilise them is not necessary. It is hoped that the material may be of assistance to those planning improvements in buildings and methods. The present volume deals with nineteen departments of physiology, anatomy, pathology, biochemistry, pharmacology, surgery, and obstetrics. The articles are written by the heads of the departments and are illustrated with plans and views. They include descriptions of the department of physiology and the Moltano Institute, Cambridge, the department of anatomy, University of Leyden, the pathological laboratory of the Johns Hopkins University and Hospital; the department of surgery, Peking Union Medical College; and the obstetrical unit, Royal Free Hospital. Brief details are appended of the staffing, finance, and lines of research and instruction given in the various institutions.

FROM the Northern Polytechnic, Holloway, London, we have received a prospectus for 1925-26 containing particulars of the three-years' course in architecture which has lately been recognised by the Royal Institute of British Architects as qualifying those who obtain a first- or second-class pass in the school examination for exemption from the R.I.B.A. intermediate examination. The Polytechnic is the only institution in Great Britain which offers courses of university grade in rubber technology. The senior day course is described as suitable for university graduates working for higher degrees who select as their subject for research problems connected with rubber. The advanced day and evening courses offer suitable preparation for the examinations for the associate diplomas awarded by the Institution of the Rubber Industry (A.I.R.I.). A Rubber Trades School has also lately been established to provide boys of fourteen to fifteen with the necessary basic training in rubber workshop practice and allied subjects previous to entering the rubber industry. The full term of apprenticeship is five years, of which the first year is spent as a full-time day course at the school, while in subsequent years the boys attend the school two evenings a week.

Early Science at Oxford.

November 30, 1683. Some Iron ore, which was dug at Wassall in Staffordshire, and had been lately calcined, was observed to draw ye needle: it being true, that scarce any Iron ore will apply to ye magnet, unless it has first undergone ye fire; This gave matter to a quære, whether fire may not be supposed to make these ores attract the needle? A little peice of a sewing needle, about $\frac{1}{4}$ of an inch long, being placed on a peice of paper, and a loadstone applied under ye paper, was seen to raise its self on its greater end; upon applying ye other pole of ye loadstone ye peice of needle affected to raise its self on its point. There followed some discourse concerning ye sawing of Diamonds, with ye hair of a man's head, as fetters are commonly saw'd off, by Prisoners, with a steel virginal string. A letter from Dr. John Bagly gave an account of some observations, he had lately made on ye *Lumbricus Latus*; particularly that in every joint of ye worm, there appears an insect, not unlike an ant, which may be seen with ye bare eye; He says a patient of his voided 100 yardes of this sort of worm in 24 hours.

1686. Dr. Plot communicated ye following curiosities: A large shell which had its turnings from ye left to ye right contrary to almost all shells hitherto described. In the Catalogue of Shells preserv'd in ye Ashmolean Repository 'tis called *Buccino-cochlea atrovirens*, a Sinistra in dextram obvoluta, mucrone obtuso, lutescenti. A sort of amphibious Crabfish from ye Island of Barbados, which when they return to sea, keep their course soe directly forward, that they usually climb over rocks, houses, and what other obstacles soever; rather than take any compasse.

The Society desired an account of ye number of Christenings and burials in Paris and London in ye years 1670 and 1671.

December 1, 1685. Dr. Bernard gave an account, that the Eclipse of the Moon the night before, could not be observed here by reason of a thick fogge at that time.

He also gave an account of a fat man that lived a fortnight together upon Tea alone, and by these means cured himself of a fitt of the Gout. Other Instances of fasting were mention'd. One John Scot in ye time of K. Hen: 8th fasted 30 or 40 dayes together in an Abbey at Edenburgh, and 32 daies in ye Castle there: He also did the like at Rome; and fasted 50 daies in prison at London. This is affirmed by Bp. Spotswood in his history of Scotland A.D. 1539. One Cisely de Ridgeway being condemned fasted 40 daies in prison, and was therefore pardoned: Dr. Plot produced a copy of her pardon, wherein her fasting 40 daies was mention'd; It was dated Anno 3^{mo} Edv. 3^{ij}. Dr. Plot said, he was credibly informed, that a Dog being casually locked up in a study at Canterbury, fasted 24 daies together, and afterwards recovered. Mr. President said, his sister told him, she had a hen, that lived without meat and drunk 9 weekes together, being by chance shut up among some faggots, and afterwards recovered. She was observed to drink much, as soon as she was released.

There was read a paper proposing a way to remember numbers by words, ye vowels whereof may represent figures; with a large scheme of instances in Chronology to that purpose.

Dr. Plot shew'd us ye skins of ye Otter fish and of ye *Canis marinus* or dog-Fish, which is not ye same with ye Sharke or *Canis Charcharias*.

December 2, 1684. The President, Director, and Secretary being all out of town, we had no meeting for a fortnight.

Societies and Academies.

LONDON.

Royal Society, November 19.—J. W. Pickering and R. J. Gladstone: The development of blood plasma. Pt. I.: The genesis of coagulable material in embryo chicks. An excess of material which is protective against the inception of clotting exists in the plasma of early embryos. This material does not possess antithrombic properties. Antithrombic material can be prepared by heating embryonic blood to 60° at the stage of development prior to the appearance of prothrombin. The inception of the coagulation of embryonic blood may occur, at room temperatures, prior to the agglutination and lysis of thrombocytes.—D. J. Scourfield: On a new type of crustacean from the Old Red Sandstone (Rhynie Chert Bed, Aberdeenshire), *Lepidocaris rhyniensis*. This form only reaches about 3 mm. in length in the fully grown adult. Both sexes in various stages of development are found. Owing to the semi-transparent nature of the Chert and the excellent preservation of minute structures therein, it has been possible to reconstruct the animal in practically all its external details. A new order of Branchiopoda, the Lipostraca, has been formed to receive it. Considered as a whole, *L. rhyniensis* does not seem to have led to any subsequent development. It was in many ways more specialised than any living anostracan, and probably fitted into a very peculiar environment. The absence of all certain traces of "pond life" organisms other than *L. rhyniensis* seems to confirm the theory that the water in which the Rhynie Chert bed was deposited may have been hot and highly charged with silica.—J. R. Norman: The development of the chondrocranium of the eel (*Anguilla vulgaris*), with observations on the comparative morphology and development of the chondrocranium in bony fishes: For purposes of comparison, the development of the chondrocranium in the herring (*Clupea*) and the salmon (*Salmo*) has been studied. A general comparative account of the morphology and development of the chondrocranium of bony fishes has been included. It is concluded that the hyomandibular of bony fishes represents the epal element of the hyoid arch, and is homologous with the hyomandibular of selachians, the interhyal of bony fishes is a new structure. The condition of hyostyly has been independently acquired in the two groups.—J. Needham and Dorothy Needham: The hydrogen-ion concentration and oxidation-reduction potential of the cell-interior before and after fertilisation: a micro-injection study of marine eggs. A study of eggs of four echinoderms, of one tunicate, and of one polychaete worm has been made by the method of micro-injection. The conclusions rest on appearances seen in 3300 injected eggs. The internal pH of all eggs studied is in the close neighbourhood of 6.6. It does not change on fertilisation, nor are any subsequent rhythmical changes to be seen. On cytolysis it is lowered to a point below 5.0 and above 4.0. The pH varies more than the pH, but it is within the limits 19 to 22; it does not change on fertilisation or cytolysis. Vital staining and micro-injection give diametrically opposite results.—R. R. Armstrong: Studies on the nature of the immunity reaction. (i.) The protective power of sera, prepared by immunising rabbits with pneumococcal vaccine, can be measured accurately against measured doses of living pneumococcal cultures, using mice as test objects. Immunity is developed in a very characteristic manner, whether it be following experimental inoculation in the rabbit

or the natural stimulus of a lobar pneumonia in man. An inductive phase, lasting from three to five days, is followed by an outpouring of protective antibodies into the serum, at a rapidly increasing rate; a maximum concentration of protective substance being reached on the eighth day after inoculation. Strict correlation is found to exist, within certain limits, between the size of the dose of vaccine administered and the degree of immunity developed. (ii.) The pneumococcus combines proportionally with its homologous protective anti-bodies to form a "sensitised" vaccine. On inoculation, a sensitised vaccine liberates the greater part of its charge of anti-bodies, rapidly conferring a slight degree of immunity; and afterwards excites an active immunity in a manner comparable with that of raw vaccine. Sensitisation, however, leads to a reduction in the intensity and to delay in the immunity response, compared with that following an equal dose of raw vaccine.—R. J. Ludford: The cytology of tar tumours. Tumours were produced by painting regularly the skin of mice with tar. Epidermal cells show changes associated with the process of keratinisation, pathological conditions, hypertrophy, and degeneration, being of common occurrence. Sebaceous glands in the thickened epidermis surrounding tar tumours show marked hypertrophy. The secretion process is essentially the same as in the normal gland. Penetration of the *panniculus carnosus* by tumour cells induces reaction on the part of the muscle fibres, seen in an increase in sarcoplasm and in number of nuclei, and also in the behaviour of cytoplasmic organs.—Eric Ponder: The inhibitory effect of blood serum on hæmolysis. The reaction is described by equations similar to absorption equations; the inhibition is probably due to the formation of a loose physical compound between the lysis and the serum proteins. The reaction is little influenced by temperature within the experimental range.—L. Brüll and F. Eichholtz: (1) The effects of calcium and potassium ions on urine secretion as studied in the whole animal. In the intact anaesthetised dog, potassium chloride injected intravenously increases the urine flow to a much higher extent than injection of corresponding amounts of sodium chloride. Potassium or calcium chloride, either isolated or combined, have no constant nor specific effect on chlorides output; the intact animal behaves as it does towards sodium chloride, using its general power of concentrating chlorides. When the pituitary body is removed, and the kidney has consequently lost its power of concentrating chlorides, the animal reacts to calcium and potassium ions as in the lung-heart-kidney preparation. Hence in the lung-heart-kidney preparation reactions of the kidney can be studied and elucidated under simplified conditions. (2) The secretion of inorganic phosphate by the kidney. Infusions of sodium or potassium solutions increase the output of inorganic phosphate and also the urine flow, but in a smaller proportion. Small amounts of calcium chloride may increase the phosphorus output; large amounts diminish or even abolish inorganic phosphate secretion. This decrease of phosphate in the urine is generally accompanied by an increase of the phosphate level of the serum.—F. Eichholtz, R. Robison, and L. Brüll: Hydrolysis of phosphoric esters by the kidney *in vivo*. The isolated kidney, perfused by means of the heart-lung preparation, which is unable to concentrate the normal inorganic phosphates of the blood serum, is able to concentrate and to hydrolyse added organic phosphates, and to excrete their phosphorus as inorganic phosphates in the urine in a much higher concentration than that of the inorganic phosphates in the serum. In the whole animal in which the

urinary inorganic phosphates have sunk to a minimum, injected organic phosphates are excreted, after an initial stage, entirely in inorganic form. It is considered that normally a considerable part, if not all, of the urinary phosphates are derived from the organic phosphates of the serum, by hydrolysis in the cells of the kidney under the action of the kidney enzyme.

Mineralogical Society, November 3—C S Garnett. The dissociation of dolomite. Further evidence in support of the conclusion that true dolomite dissociates under the influence of heat in a single step and not in two stages as formerly supposed. The setting of semi-burnt dolomite with water is due to free lime and not to a mixture of magnesium oxide and calcium carbonate.—B J Tully. A new refractometer. The special features of this new refractometer are thorough rigidity and an exceptionally large and flat field of vision due to the long optical system employed, the shadow edges being straight instead of curved as in older types. All adjustments for focusing, lighting, etc., being independent of the main body which contains the optical system and graticule scale in a dust-proof enclosure, little damage is possible by inexperienced usage.—A Russell. Notes on some new British localities for barytocalcite and alstonite. Barytocalcite is found at Ayleburn Mine, Northumberland, 2 miles north of Alston, where it occurs, abundantly and well crystallised, with blende in brown limestone. Heartycleugh Mine, West Allendale, Northumberland, in small quantity with barytes, and Lolly Scar Mine, Nidderdale, Yorkshire, massive and in small crystals with fluor, chalcopyrite, witherite, etc. Alstonite, massive and in crystals of the usual habit, was found as a single specimen in the witherite vein worked in Ushaw Moor Colliery, near Durham.—G T. Prior. The meteoric iron of Vaalburg and meteoric stones of Witklip and Queens Mercy, South Africa. A mass of meteoric iron weighing 26 lb was found on Vaalburg farm, Prieska Division, Cape Province. It is a coarse octahedrite having about 7 per cent of nickel, with a ratio of iron to nickel of about 13. The Witklip stone fell on May 26, 1918, on the farm Witklip in Carolina District, Transvaal, after a loud explosion and a flash of light. It is a grey chondrite resembling Cronstad. Only a few grams appear to have been preserved. The Queens Mercy stone is also a grey chondrite which fell on April 30, 1925, about 20 miles from Matatiele, Cape Province, after the appearance of a bright light and a loud detonation. The stone, which measured about 1½ ft in length, was broken up by the natives and only a few fragments have been recovered.

Society of Public Analysts, November 4—G D Elsdon and Percy Smith. The determination of palm kernel oil and butter in margarine. The Reichert, Polenske and Kirschner values of a series of mixtures of palm kernel oil and butter fat in mixtures of other oils and fats have been determined. The differences between the calculated and observed values are very much less in the case of palm kernel oil than in the case of coconut oil, the relationship between the Reichert and Polenske value of a given mixture may assist in deciding on the relative proportions of palm kernel oil and coconut oil present.—Clive Newcomb. The determination of alcohol and ethyl chloride in chloroform. Alcohol is removed by washing with water in a special apparatus, and by determining the density of the chloroform before and after the washing a measure of the amount of alcohol is obtained, whilst the difference between the density of the washed chloroform and that of pure chloroform affords a

measure of the amount of ethyl chloride.—H Atkinson. The volumetric determination of soluble sulphates by means of barium chloride and potassium stearate. Sulphates in fairly dilute solution can be determined by precipitating them with excess of standard barium chloride solution, and titrating this excess with standard potassium stearate solution, the end point being shown by B D H universal indicator. Metals forming insoluble stearates (e.g. aluminium, zinc, calcium, magnesium) are removed by precipitation with the potassium stearate solution prior to the titration of the sulphate. The limit of error in the method is of the order of 0.05 c.c. of a 0.1 N solution.

Linnean Society, November 5—Marius Maxwell. The home of the eastern gorilla.—Miss E Bolton. Validity of certain species in Neuropteris, Brongni.

November 19—H S Holden and S H Clarke. On the seedling structure of *Tilia europaea*.—L R Crawshaw. Sponge fishery investigations in the British West Indies. The investigations were instituted by the Colonial Office in 1920. Among the problems requiring attention are that of depletion of the sponge beds through unrestricted removal of the sponges over many years past, and the cultivation of sponges from planted cuttings. The latter offers undoubtedly valuable possibilities of development of a sponge fishery along the best lines for the improvement and extension of its resources. The general subject of sponge-fishery control can only properly be dealt with in the light of knowledge gradually to be obtained by study of the living sponges, and especially in regard to the relationships of the chief market types, and their form-variations, age, growth and growth-rate, and reproduction.—G Claridge Druce. Recent additions to the British flora.

Mathematical Society, November 12—H B C Darling. Expansion of the elliptic integrals u and $E(u)$ in series of sines of multiples of the amplitude.—H Hilton and Sybil D Jervis. On plane quartic curves with a triple point.—C G F James. (1) On cycles of corresponding points in Cremona transformations. (2) Generation of quadratic plane transformations by means of double projection.—P A MacMahon. Euler's ϕ -function and its connection with multipartite numbers.—W P Milne. The harmonic and equianharmonic envelope of a cubic surface.—C A. Stewart. The integration of linear partial differential equations with constant coefficients and distinct characteristics.—E C Titchmarsh. A series inversion formula.—C E Weatherburn. On congruences of curves.—E M Wellish. Electric and magnetic displacement currents.—F J W Whipple. (1) On well-poised series, generalised hypergeometric series having parameters in pairs, each pair with the same sum. (2) Well-poised series and other generalised hypergeometric series.

Royal Anthropological Institute (Indian Section), November 17.—E H Hunt. Hyderabad cairn burials. At "Mauli Ah, South," last May, five burials were opened. Finds included the bones of a hare in a pot, bovine teeth, much iron, pottery showing new features, and a fine gold spiral, with a large number of minute gold rings, other rings were of silver, plated with gold. These burials differed in type from those of Raigar and elsewhere in that the cist slabs were vertical, and overlapped at the ends. In the north slab, a large round hole had been cut, bringing these underground burials into line with the surface "holed dolmens" of Rajunkalur. In May 1923, further investigations

were made, with Mr. L. Munn, into the ancient iron industry of the Hyderabad State. No limiting date can be placed on the smelting of iron in South India. Continued study of the literature of the subject yields little, though excellent descriptions of surface conditions are given by the older writers. Destruction of these remains is rapid, their chief enemy being the cultivation of castor seed. At least six distinct types of burials can be distinguished, and the total period covered must extend to thousands rather than hundreds of years. Some types must be far older than others, but before any attempt at "sequence dating" can be begun, there must be much organised and careful excavation. There is urgent need for the provision of some central collecting station where type-specimens of pottery, beads, rings, human and animal remains, articles of gold, silver, copper, and iron, etc., can be collected for comparative study. England appears to be the natural place for this, but, so far, no museum affords the requisite housing space.

Royal Statistical Society, November 17.—G. Udny Yule. Why do we sometimes get nonsense-correlations between time-series?—a study in sampling and the nature of time-series. (Presidential address.) When graphs are plotted of (1) the standardised mortality in England and Wales, 1866–1911, (2) the proportion of Church of England marriages to all marriages during the same years, they shew a very close relationship, measured by a coefficient of correlation of more than +0.9. Such a correlation is completely nonsensical; but the fact that we can get such correlations leads us to mistrust the serious arguments that have sometimes been based on time correlations. Even though two simple functions of time are completely independent when the correlation is considered over a long period, short "time-samples" tend to give correlations departing as far as possible from the truth and approaching ± 1 . Turning to empirical series, a method of classification is suggested based on the "serial correlations" for the series, that is, the correlations between terms distant from each other by 1, 2, 3, . . . units of time. The dangerous class of series is that for which not only the serial correlations for the series itself but also those for its first differences are all positive. Applying the method of serial correlations to the analysis of Sir William Beveridge's index-numbers for wheat prices in Western Europe, 1545–1844, and also to rainfall at Greenwich, 1815–1924, the differences of the former series are found to be oscillatory, as in Sir William Beveridge's periodogram analysis, while the latter appears to be mainly random.

PARIS.

*Academy of Sciences, October 12.—J. Costantin: Two new experimental stations of *Pleurotus Eryngii*. An account of two attempts to grow this edible fungus at Guignecourt-sur-Vence (Ardennes) and the forest of Fontainebleau.—André Blondel: Measurement of the photometric yields of optical apparatus.—A. Vayssière: The nymphosis and metamorphosis of a *Prosopistoma foliaceum*.—E. Bataillon: New technical methods for the study of gastrulation and germinal localisations in the batrachians.—Georges J. Rémondos: The extension of Picard's theorem to multiform functions.—E. Baticle: The correction of the effects due to permanent expansions or contractions in concrete arches.—Thadée Peczkalski: The cementation of metals by volatile salts. Study of the effects of prolonged heating of iron and copper in contact with fused chromium chloride and fused

nickel chloride. The penetration of copper by nickel under these conditions is shown by microphotographs.—L. Meunier and A. Bonnet: The fluorescence of the colouring matters of plants. The fluorescence under Wood's light is of value in the characterisation of commercial tinctorial extracts.—Volmar: The photolysis of the ethylenic dibasic acids. Fumaric, maleic, mesaconic, itaconic and citraconic acids have been exposed to ultra-violet light under comparable conditions, and the volumes of gas produced measured. The unsaturated acids are more easily decomposed by ultra-violet light than the corresponding saturated acids. The *cis* isomers are more readily decomposed than the *trans* isomers.—A. Gruvel: A fishing map of a part of the western coast of Morocco.—C. T. Popesco: Movements of sleep and awakening compared in *Desmodium canadense* ungrafted and grafted.—Risbec: The production of light by a nudibranch mollusc from New Caledonia. This mollusc, named provisionally *Triopa fulgurans*, emits a series of short bright flashes when disturbed.—J. Athanasio: The nervous mechanism of the rhythmicity of the myocardium.—P. Lasareff: The change in the electrical conductivity of the visual purple during illumination. The retinal purple of the frog was dissolved in solution of bile salts, and submitted to prolonged dialysis. The increase in the electrical conductivity produced by illumination was determined and could be expressed by the formula $\sigma = a - be^{-at}$, where σ is the electrical conductivity, a and b constants, t the time, and a a constant depending on the light intensity. These experiments are regarded by the author as giving an experimental basis to his ionic theory of luminous sensations.—Samec: The chemico-colloidal properties of the components of starch.—P. Cappe de Baillon: The embryogenesis of double monsters in phasmids (*Carausius morosus*).—Pierre P. Grassé: The vacuome and Golgi apparatus in Euglena.

MELBOURNE.

Royal Society of Victoria, September 24.—G. A. Ampt and E. J. Hartung: Occurrence of helium in a spa gas, Victoria. A distinctly radioactive spa gas from Hepburn, Victoria, was analysed for helium by standard methods. The volume composition proved to be: carbon dioxide 97.0, nitrogen 2.55, oxygen 0.46, inert gas 0.045 per cent. The last was shown to be a mixture of argon and helium, with traces of neon. Its average molecular weight was 35.1, as determined by an Aston density balance, and corresponded with 13.4 per cent. of helium. The volume concentration of helium in the spa gas was therefore 6 parts in 100,000. This is the first recorded occurrence of helium in any Australian natural gas.—E. F. J. Love: A low-lag thermocouple with a novel type of insulation. A method of insulating wires and thermojunctions by means of a thin film of rubber, deposited from solution in benzine—petroleum motor spirit—and afterwards vulcanised with sulphur chloride. Couples so insulated are found to have a very small lag and have proved of service in some recent experiments on meat refrigeration. As the materials required are regular articles of commerce and the operations simple, the method may find other applications.—D. K. Picken: Geometry, the basic physical science; a modern equivalent to Euclid. This is the final paper of a series published in the *London Math. Soc. Proc.* (ser. 2, vol. 23, pt. i.) and in the *Math. Gaz.* (Dec. 1922, Oct. 1924). An attempt is made to recover the point of view of the Greek philosopher-geometers, while embodying all the essential relevant ideas

that have accrued in modern times. This paper discusses the fundamental definitions and axioms of geometry—especially the necessary axioms of order—and a natural logical sequence of propositions. The "complete angle" method is used to resolve outstanding difficulties in the proof of Euc. i 8—A. W. Turner. Sensitising powers of parasite proteins. By using Dale and Laidlaw's isolated sensitised guinea-pig uterus technique, the biological relationship of some metazoan parasites (Nematoda, Trematoda, and Arthropoda) were investigated: Uteri sensitised by proteins from one species of a genus may exhibit non-specific sensitiveness towards another species, but after being desensitised to the non-specific factor, delicate specific sensitiveness towards the sensitising proteins remained. If first desensitised against the sensitising proteins, uteri exhibit no non-specific sensitiveness. There is an analogy between this phenomenon and group agglutination and precipitation. The method may be useful for specifically diagnosing mutilated parasites—A. J. Ewart, Lesley R. Kerr, and E. M. Derrick. Contributions to the flora of Australia (30). An account is given of the first results of the examination of a collection of plants made by Prof. Ewart during a visit to Central Australia in 1924. It consists mainly of new or additional records, the new species being kept for a later paper. Attention is directed to the existence of a large belt of timber of *Casuarina*, *Decasmanian* south of the McDonnell Ranges, the existence of which may prove of considerable importance in connexion with the approaching extension of the railway from Oodnadatta to Stuart in the McDonnell Ranges. The character of the vegetation in many areas north of the McDonnell Ranges indicates the existence of land valuable not merely for grazing but also in the future for quickly ripening summer grain crops. Far from being a desert, much of this land is highly fertile and has a rainfall of 12 to 20 inches. Interspersed with these areas are, however, large tracts of sandy porcupine grass country representing a difficult problem of economic handling and treatment.

VIENNA

Academy of Sciences, October 15—G. Weissenberger, R. Henke and L. Bregmann. Divalent phenols and their ethers.—G. Weissenberger, R. Henke and E. Sperling. The behaviour of deka-hydro-naphthalin.—M. Kohn and S. Sussmann. Some tri- and tetra-halogen-phenols.—R. Weiss and K. Woidich: On 1-phenyl-naphthalin and its derivatives.—J. Pollak and E. G. Fulnegg. On derivatives of resorcin.—H. Michel. The fall and finding of a meteoric stone at Lanzenkirchen, Lower Austria. Eye-witnesses in Wiener Neustadt report that on August 25, 7.30 p.m., a fireball emerged from between the clouds, burst asunder and fell to earth in rapidly fading pieces. After 20 to 30 seconds, according to the distance of the observer, several shot-like detonations followed by irregular thunder roll for a minute were heard. The meteor left a vivid shining track. Next day Herr Flickentanz found a peculiar hole in his meadow. Half a metre deep was a meteoritic stone weighing more than 5 kgm., the size of a child's head.—O. Furth and J. Marian: On the decomposition of hexosediphosphoric acid in the mammalian organism.—E. Cartellieri: Contributions to our knowledge of the absorption system of Rafflesiaceae Brugmansia.—O. Koller: A new species of *Barbus* from Albania, from the stream Fandi Vogelj.—J. Schädler. Scharizerit, a new mineral from the dragon cave at Mixnitz in Styria, has a high nitrogen content.

Official Publications Received.

- Bergens Museums Aarbok 1924-25 Hefte 1. Naturvidenskabelig række. Pp. 38+18+54+11+46. (Bergen.)
- Sydney University Reprints. Series 1 (Agriculture and Veterinary Science), Vol. 1, Nos. 1-7. Series 2 (Botany), Vol. 1, Nos. 1-17. Series 3 (Chemistry, Organic and Inorganic), Vol. 1, Nos. 1-32. Series 6 (Geology and Geography), Vol. 1, Nos. 1-20. Series 9 (Medical Sciences—Non-Chemical), Vol. 1, Nos. 1-16. Series 11 (Physics, Mathematics and Astronomy), Vol. 1, Nos. 1-7. Series 12 (Social Science—Economics, Education, History, Philosophy and Psychology), Vol. 1, Nos. 1-10. Series 13 (Zoology), Vol. 1, Nos. 1-23. (Sydney.)
- United States Department of Agriculture. Department Bulletin No. 1336. Biological Studies of the Green Clover Worm. By Chas. C. Hill. Pp. 20. (Washington: Government Printing Office.) 5 cents.
- Annual Report of the Meteorological Committee to the Air Council for the Year ended 31st March 1925. (M.O. 274.) Pp. 64. (London: H.M. Stationery Office.) 1s. 9d. net.
- Union of South Africa. Department of Agriculture. Science Bulletin No. 40 (Division of Chemistry Series No. 60). Chemical Investigations in regard to Citrus. By Dr. Chas. F. Juritz. Pp. 22. (Pretoria: Government Printing and Stationery Office.) 3d.
- Aeronautical Research Committee. Reports and Memoranda, No. 975 (Ae. 189). Autorotation Measurements on a Model Aeroplane with Zero Stagger. By F. B. Bradfield and L. P. Comb's. (A.2.a. Stability, Calculations and Model Experiments, 93—T. 2072.) Pp. 7+4 plates. (London: H.M. Stationery Office.) 6d. net.
- Transactions of the Royal Geographical Society of Australasia (Queensland). Reports of the Great Barrier Reef Committee. Vol. 1. Edited by Dr. J. P. Thomson and C. Hedley. Pp. xi+175+25 plates. (Brisbane.) 10s.
- Annual Report on the Working of the Museum Department during 1924-25. Pp. vi. (Malta: Government Printing Office.)
- Ministry of Finance, Egypt. Petroleum Research, Bulletin No. 9: Preliminary Geological Report on Gebel Khoshra Area (Western Sinai). By F. W. Moon and Dr. H. Sadek, with Appendix by T. H. Withers (On a new Crab from the Miocene). Pp. v+40+14 plates. (Cairo: Government Publications Office.) 10 P.T.
- Methods and Problems of Medical Education. (Third Series.) Pp. 242. (New York: The Rockefeller Foundation.)
- Field Museum of Natural History. Geological Series, Vol. 4, No. 4. On the Head of the Macropetalichthyids, with certain Remarks on the Head of the other Arthrodies. By Erik A. von Stensio. (Publication 242.) Pp. 85+197+plates 19-31. (Chicago.)
- Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 5, 1923. 3: Vattenståndet vid Rikets kuster. Pp. ii+21. (Stockholm.) 2 kr.
- Government of the Gold Coast. Report on the Survey Department for the Period April 1924-March 1925. Pp. 26+3 plates+2 maps. (Accra: Colonial Secretariat, London: The Crown Agents for the Colonies.) 2s.
- Field Museum of Natural History. Zoological Series, Vol. 12, No. 9: The Long-Clawed South American Rodents of the Genus *Notiomys*. By Wilfred H. Osgood. Reports on Results of the Captain Marshall Field Expeditions. (Publication 239.) Pp. 111+125+1 plate. Zoological Series, Vol. 12, No. 10: New Coral Snakes from Peru. By Karl P. Schmidt and F. J. W. Schmidt. Reports on Results of the Captain Marshall Field Expeditions. (Publication 280.) Pp. 127+134+2 plates. Zoological Series, Vol. 12, No. 11: A Review of the Fishes of the Genus *Signalosa*. By Alfred C. Weed. Reports on Results of the Captain Marshall Field Expeditions. (Publication 233.) Pp. 135+146. (Chicago.)
- Forest Bulletin No. 63 (Botany Series). *Eucalyptus* Trials in the Simla Hills. By R. N. Parker. Pp. 27. (Calcutta: Government of India Central Publication Branch.) 8 annas. 10d.
- British Honduras. Annual Report of the Forest Trust for the Year ended 31st March 1925. Pp. 25. (Belize.)
- Annual Breeding Research Department: The University, Edinburgh. Report of the Director for the Year April 1st, 1924, to March 31st, 1925 (Using the 5th Annual Report). Pp. 21. (Edinburgh.)
- Occasional Papers of the Society for the Preservation of the Fauna of the Empire, No. 1. The Tsetse-Fly Problem and its Solution. Pp. 10. (London.)
- Proceedings of the Geologists' Association. Vol. 36, Part 3, October 25. Edited by A. K. Wells. Pp. 203-320. (London: Edward Stanford, Ltd.) 5s.
- Journal of the Indian Institute of Science. Vol. 5B, Part 1: Lecher Wire Measurements. By S. R. Kantabet. Pp. 10+5 plates. (Bangalore.) 1 rupee.
- Svenska Hydrografisk-Biologiska Kommissionens Fyrskottsundersökning, År 1924. Pp. 39. (Göteborg: Elanders Boktryckeri Aktiebolag.)
- University of Illinois Engineering Experiment Station. Bulletin No. 118. Radio Telephone Modulation. By Hugh A. Brown and Charles A. Keener. Pp. 49. 30 cents. Bulletin No. 149. An Investigation of the Efficiency and Durability of Spur Gears. By Prof. C. W. Ham and J. W. Huckert. Pp. 94. 50 cents. (Urbana, Ill.)
- Egyptian Government. Anti-Malaria Commission. The Mosquitoes of Egypt. By T. W. Kirkpatrick. Pp. xii+221+24 plates+2 maps. (Cairo: Government Publications Office.) 30 P.T.
- Ministry of Agriculture and Fisheries. Intelligence Department. Report on the Work of the Intelligence Department of the Ministry for the Three Years 1921-24. Pp. 163. (London: H.M. Stationery Office.) 6s. net.
- Aeronautical Research Committee. Reports and Memoranda, No. 973 (Ae. 188). The Lateral Control of a Biplane by Combined Use of Ailerons and varying Leading Edge Slots. By Dr. G. P. Douglas, F. B. Bradfield and A. S. Hartshorn. (A.2.a. Stability, Calculations and Model Experiments, 92—T. 2060.) Pp. 14+12 plates. (London: H.M. Stationery Office.) 1s. net.
- Transactions of the Royal Society of Edinburgh. Vol. 54, Part 2, No. 4: A Monograph on the General Morphology of the Myxinoide Fishes, based on a Study of Myxine. Part 6: The Morphology of the Vascular System. By Prof. F. J. Cole. Pp. 309+342+5 plates. (Edinburgh: R. Grant and Son, London: Williams and Norgate, Ltd.) 6s.

Diary of Societies.

SATURDAY, NOVEMBER 28.

JUNIOR INSTITUTION OF ENGINEERS (at Shipping Engineering and Machinery Exhibition at Olympia), at 3.—T. E. Dumbleby. Introduction as an Aid to an Industrial Revival (Lecture).

MONDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

ROYAL IRISH ACADEMY, at 4.15.

INSTITUTE OF ACTUARIES, at 5.—D. Houseman: Some Notes on the Changes made by the New Law of Property Acts, with special reference to Life Assurance Practice.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at South Wales Institute of Engineers, Cardiff), at 6.—J. H. Thomas. Switch-gear Developments during the Past Twenty Years (Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Dr R. Lessing. Coal Ash and Clean Coal (Cantor Lecture II).

TUESDAY, DECEMBER 1.

INSTITUTION OF CIVIL ENGINEERS, at 6.—H. A. Reed: Trafford Wharf Reconstruction at the Manchester Docks.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.—Capt R. K. Hubbard. The Requirements of the Military Motor Vehicle.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at 17 Albert Square, Manchester), at 7.—T. Carter. The Engineer, his Due and his Duty in Life (Lecture).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—T. H. B. Scott. Lourdes Revisited.

INSTITUTE OF METALS (Birmingham Local Section) (in the Chamber of Commerce, New Street), at 7.—Discussion on The Production of Sound Ingots.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Broadgate Cafe, Coventry) (Coventry Graduates' Meeting), at 7.15.—G. H. Day. Some Notes on Service.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Technical College, Cardiff), at 7.30.—O. Bateman. Manufacture and Neutralisation of Ammonium Sulphate.

INSTITUTE OF METALS (North-East Coast Local Section) (in the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne), at 7.30.—Dr. M. Cook. The Solidification of Metals.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—G. Butler. The Products and By-Products of a Modern Iron and Steel Works.

INSTITUTE OF MARINE ENGINEERS (at Shipping Engineering and Machinery Exhibition at Olympia), at 8.—A. C. Hardy. Motor Ship Progress in 1925.

ROENTGEN SOCIETY (at British Institute of Radiology), at 8.15.—R. J. Stephenson: A Study of Interrupters for Induction Coils.—Dr. E. A. Owen. Oscillographic Observations on Induction Coils and Transformers.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Z. le Rouzic. Les Monuments mégalithiques du Morbihan; leur définition, leur destination et leur âge d'après les dernières découvertes aux environs de Carnac.

WEDNESDAY, DECEMBER 2.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—R. D. Oldham. The Depth of Origin of Earthquakes.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—H. F. Molony. Escalators on the Central London Railway.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—H. A. Thomas. The Performance of Amplifiers.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Prof. S. P. Smith. An All-Electric House.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Shipping Engineering and Machinery Exhibition at Olympia), at 7.30.—J. E. Boaz. The Requirements of Ablutionary and Recreative Bathing Establishments as affecting the Heating and Ventilating Engineer.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. J. S. Owens: Measuring the Smoke Pollution of City Air.—Dr. O. L. Brady. 2. 4-Dinitrophenylhydrazine as a Reagent for Aldehydes and Ketones.—G. Jorgensen: The Determination of Phosphoric Acid as Magnesium Ammonium Phosphate.—O. H. Thomson: On the Effect of "Blowing" on the Composition of Certain Fatty Oils.

ROYAL SOCIETY OF ARTS, at 8.—Lt.-Col. Sir Alan H. Burgoyne. The Future of the Motor Car.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, DECEMBER 3.

ROYAL SOCIETY, at 4.30.—W. A. Bone and G. W. Andrew. Studies in Catalytic Combustion. Part II. The Union of Carbon Monoxide and Oxygen in contact with Nickel Copper and other Oxides.—F. H. Constable: Immovable Groups of Atoms with Strong Specific External Fields as the Cause of Catalytic Activity.—S. C. Roy. On the Law and Mechanism of Monomolecular Reaction.—F. A. Williams: The Effect of Temperature on the Viscosity of Air.—R. W. Fenning: Gaseous Combustion at Medium Pressures. Parts I. and II.—R. K. Schofield and E. K. Rideal. The Kinetic Theory of Surface Films. Part II.—To be read in title only.—H. B. Dixon and G. Greenwood. On the Velocity of Sound in Mixtures of Gases.—A. Fage and L. F. G. Simmonds. An Investigation of the Air-Flow Pattern in the Wake of an Aerofoil of Finite Span.—W. L. Webster. Magneto-Striction in Iron Crystals.—R. W. James and W. A. Wood. The Crystal Structure

of Barytes, Celestine, and Anglesite.—O. Maass and J. H. Meunier: Aberrations from the Ideal Gas Laws in Systems of One and Two Components.—R. G. Lunn: Fluid Resistance to Moving Spheres.—W. G. Palmer. The Adsorptive Equilibria of Binary Gaseous Mixtures.—I. Sandeman: The Secondary Spectrum of Hydrogen at Higher Pressures II.—P. A. M. Dirac. The Fundamental Equations of Quantum Mechanics.

LINNEAN SOCIETY OF LONDON, at 5.

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Prof. B. Melville Jones: The Control of Stalled Aeroplanes.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Prof. S. P. Smith: An All-Electric House.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB, at 7.30.—A. Stevens. Arctic Exploration.

INSTITUTION OF STRUCTURAL ENGINEERS, at 7.30.—H. G. Lloyd. A Method of Testing Concrete Blocks.

CHEMICAL SOCIETY, at 8.—B. Lewis and E. K. Rideal. On the Budded Effect in Bromine. Part I. The Photoactive Constituent in Wet Bromine. Part II. The Kinetics of the Reaction and the Light Absorption of Wet and Dry Bromine.—R. Gane and C. K. Ingold. The Influence of Carbon Rings in the Velocity of Reactions involving their Side-chains. Part I. The Hydrolysis of Cyclic and Open-chain Malonic Esters.—H. V. A. Briscoe, P. L. Robinson, and G. E. Stephenson: The Density of Boric Oxide Glass and the Suspected Variation in the Atomic Weight of Boron.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Local Meeting)—Sir John A. F. Aspinall. Some Railway Notes Old and New (Thomas Hawksley Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Local Meeting).—H. F. L. Orcutt: Characteristics and Uses of Ground Gears.

FRIDAY, DECEMBER 4.

INSTITUTION OF WATER ENGINEERS (at Geological Society), at 10.30 A.M.—Dr J. C. Thresh and J. F. Beale: Recent Studies relating to the Purification of Water, and the Action of Various Waters on Lead and Copper Pipes.—Dr. W. Rushton and P. A. Aubin. Further Observations on the Biology of Jersey Waterworks.—W. N. McClean: An Analysis of Scottish Rainfall Records.—Lt.-Col. J. R. Davidson: The Afforestation of Watersheds.—H. E. Stiggoe: The London Water Supply (Lecture).

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Sir Gilbert Walker. Vortical Theories in Meteorology, followed by E. V. Newham. Chairman, Sir Napier Shaw.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—M. Barash: A Standard Method for the Determination of the Agglutinating Value of Coal.—C. M. Keyworth and Dr. R. B. Forster. The Separation of R, G, Schaffer and Crocin Acids and their Arylamine Salt.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Pictorial Group Meeting.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—T. Thorne Baker. The Role of Photomicrography in the History of Plate Making.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. E. Bowyer-Lowe: Super Heterodyne Reception.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.30.—G. Constantinesco: Transmission of Power—the Present and the Future.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. W. D. Fung. The Submerged Forest at the Mouth of the River Char, and the History of that River.—S. W. Wooldridge: Some Phases in the Structural Evolution of the London Basin.

SATURDAY, DECEMBER 5.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Miss G. Lister. Swiss Memories (Lecture).

PUBLIC LECTURES.

SATURDAY, NOVEMBER 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Luck of an Old Shoe.

MONDAY, NOVEMBER 30.

UNIVERSITY COLLEGE, at 4.30.—Prof. Y. Henderson: The Efficiency of the Heart and its Measurement. (Succeeding Lecture on December 1.)

UNIVERSITY OF LEEDS, at 5.15.—Dr. G. W. C. Kaye. X-Rays in Industry.—At 8.—Sir Henry Hadow. Chamber Music, illustrated from the Elizabethans and J. S. Bach.

TUESDAY, DECEMBER 1.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley. The Philosophy of Aristotle; Theory of Art. Characteristics of Aristotle's Genius.

THURSDAY, DECEMBER 3.

FINSBURY TECHNICAL COLLEGE, at 4.—F. H. Carr: The Scientific Basis of Industry (Streetfield Memorial Lecture).

FRIDAY, DECEMBER 4.

ST. THOMAS'S HOSPITAL, at 5.—Prof. F. G. Parsons. The Earlier Inhabitants of London.

SATURDAY, DECEMBER 5.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Travel and Transport in Ancient Egypt.



SATURDAY, DECEMBER 5, 1925.

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Atomic Structure and the Quantum Theory.

WE publish this week, as a special supplement, the substance of an address by Prof. N. Bohr on the development of the theory of atomic structure, and in particular of the latest form and tendencies of the quantum theory in their relation to mechanics. New points are raised which seem likely to be of such importance that some attempt at a general description may be of interest. The prevailing theory of atomic structure, which we owe so largely to Prof. Bohr himself, might be characterised as "the central orbit theory." In this theory we visualise the atom as a nucleus surrounded by electrons. Each of these moves in a mechanical (but non-radiating) nearly central orbit, characterised by special fixed values of energy and angular momentum which are functions of two quantum numbers. The immense success of this theory in co-ordinating the facts of optical and X-ray spectroscopy and the general physical and chemical periodic properties of the elements is well known, and its correctness in broad outline is scarcely open to question. But it is equally certain that in its finer details the theory has proved inadequate. As soon, for example, as we begin to ask why the D-lines of sodium are a doublet instead of a single line, we leave the certain field of the theory for far less certain extensions. We can introduce formally the third quantum number necessary to "explain" the doubling (trebling, etc.) of spectral lines, and similarly the fourth quantum number necessary to "explain" their splitting in a magnetic field. Such "explanations" are elegant in form and convincing so far as they go, but when we try to interpret them on the basis of natural extensions of the mechanical model of the central orbit theory, we meet at every turn with perplexing contradictions which suggest that the proposed revision of the theory has up till now scarcely been sufficiently fundamental.

On another point the prevailing theory has proved somewhat inadequate. It has put forward a semi-mechanical model of the atom, which possesses mechanical frequencies. It is well known, however, that these differ from the observable frequencies of the atom, as shown, in the only way they can be shown, by their action on and-reaction to radiation. There is only an asymptotic equality between the two sets of frequencies for large quantum numbers. The theory has, however, been able to derive the exact observable frequencies from the mechanical frequencies by a *transformation* (Bohr's frequency condition) which forms an essential part of the postulates of the theory. The asymptotic equality, however, between the properties of the mechanical model and of the atom of any quantum

theory seems certain to subsist, not merely for frequencies but, generally, for all properties, including amplitudes or intensities of the various component oscillations. Underlying this there is doubtless an exact intensity relationship to be brought to light by a suitable transformation of the mechanical one, as Bohr's transformation brought to light the exact relationship for frequencies. Special cases of this relationship have already been recognised and embodied in what have been called "refined" applications of the correspondence principle. Some are old, such as the selection and polarisation rules: others more recent and perhaps more artificial, such as the summation rule, and the general intensity rules for multiplets and for the components of a line split by a magnetic field. But these are only special cases, and one can scarcely rest content with any transformation which utilises less than all the information about intensities as well as frequencies which the model can provide.

These and other similar ideas underlie the new attempt to formulate a more satisfactory theory, recently made by Heisenberg. Heisenberg's "transformation" of the equations of mechanics is much more general than Bohr's. Every mechanical quantity appearing is transformed at once in the new theory into an observable quantum quantity, so that the new theory does employ *all* the available information and provides complete intensity rules as well as frequencies for any soluble model. The mathematics required will be severe—in particular, the necessary algebra must obey a non-commutative law of multiplication and progress may be slow. In fact, once again physical theory seems likely to be a source of inspiration to mathematical thought. But enough appears to have been done to make it most probable that the new quantum theory will be still more fertile than the old, and to justify a hope that it may resolve some at least of the difficulties which now confront extensions of the older theory. Students of the quantum theory will wait with impatience for the publication of the results hinted at in Prof. Bohr's concluding paragraphs.

Weeds and their Control.

Ugress i nutidens jordbruk (Weeds in present-day agriculture). By Emil Korsmo. Pp. 694. (Oslo, Norway: J. W. Cappelens, 1925.)

THE eradication of weeds is regarded by many people as merely a matter of practical farming to which scientific methods have no application. This, however, is far from being the case, and it would be equally logical to deny the importance of science in other branches of agriculture. The possibility of effective control will increase in proportion to the increase in our knowledge of the plants usually regarded as weeds, especially with regard to their habits and

conditions of growth, revealing vulnerable points at which they may effectively be attacked.

The close study of weeds, with the direct objective of methods of control, brings to light valuable and interesting biological characters and relations of many widespread and common plants. Biological investigation from this point of view is a comparatively recent development, and no comprehensive work on the subject has hitherto been published, rendering this volume by E. Korsmo (professor in weed science at the Norwegian Agricultural College at Aas) a most welcome addition to botanical and agricultural literature. The book comprises the results of laborious and careful researches, representing much pioneer work, and extending over a period of thirty years. The author, however, is fully justified for the labour expended, as it must be admitted that the volume is probably the most valuable, from the biological point of view, of those hitherto published on the subject. The extensive collection of facts and their careful treatment are quite convincing, and reveal a power of observation combined with a patience in research which must awaken admiration. To sum up, the work is as conclusive as it is comprehensive and interesting.

At the outset, weeds are classified into biological groups determined by the author from the practical point of view, as follows:

- (1) Weeds multiplied by seeds only, including annual, "winter annual," and biennial plants.
- (2) Perennial weeds which multiply by seeds but may form clusters of shoots if the root is injured.
- (3) Perennial weeds which multiply mainly by creeping shoots.

Under each of these headings are various subdivisions which differentiate Korsmo's classification from those usually employed, and are based essentially upon differences of habit. Every species dealt with is minutely described throughout its life-history from seed to seed, and the numerous careful and detailed drawings make the book of great value to botanists as well as to agriculturists. Indeed two-thirds of the book is devoted to the botanical aspect of the subject. The scope of the work may be indicated by a reference to *Chenopodium album*. Its appearance, distribution, times of flowering and ripening of seed are given, together with large-scale drawings. The power of germination of the seed after burial at different depths has been determined by direct experiment, and the occurrence of the seeds in such substances as chaff, hay refuse, seed mixtures, dung, etc., is outlined. The description concludes by analyses of the mineral constituents of the plant, showing to some extent it demands upon the soil, and analyses of the organic constituents, which may indicate its feeding value for animals. Most of the work is original throughout, but

various figures and statements are quoted from other authors to strengthen the arguments or to point out the different results sometimes obtained under other conditions.

On the practical side is set forth the damage wrought by weeds, their differing capacities for spreading themselves and the best means of eradication and control. The value of systematic weed eradication is emphasised by numerous figures from experimental trials showing considerable increases of crop where good methods have been adopted. These chapters are of special interest to the practical farmer, and if the advice given were carefully followed out it should result in considerable decrease in the weed population, and a corresponding increase in the space available in the fields for actual crop growth. For many years Korsmo has been adopted by the government as weed adviser to the farmers, and has in that capacity gained a wide practical experience. His fundamental idea is to show the possibility of an economic fight against weeds, provided it be acknowledged that the old time-honoured methods are not sufficient, and that newer and more scientific methods must be brought into play, and he has endeavoured to point out that under these conditions excellent results have been obtained.

The book is written in Norwegian, making it comparatively inaccessible to the ordinary student, and an English translation is much to be desired to bring it within reach of the many whom it will deeply interest.

A. Å.

W. E. B.

Medieval Anatomy.

Monumenta Medica. Under the General Editorship of Henry E. Sigerist. Vol. 2: *The Fasciculus di Medicina, Venice, 1493.* With an Introduction, etc., by Charles Singer. Part 1: *Description of the Fasciculus; Discussion of its Editions, Art, Language, Sources, and Influence; Translation of the "Anathomia" of Mondino da Luzzi; An Account of Medieval Anatomy and Physiology; and an Atlas of Illustrative Figures from Manuscript and Printed Sources.* Pp. 112 + 73 (Atlas). Part 2: *Facsimile.* Pp. 108. (Florence: R. Lier and Co.; London: D. Stanton, 90 North Road, Highgate, 1925.) Half-linen, 66s.; half-leather, 80s.

THESE two stately volumes, which form an abiding memorial of Dr. Singer's scholarship and research, will appeal alike to the medical historian, the antiquarian, and the artist.

The "Fasciculus di Medicina" is a collection of medical treatises which was first printed in Latin at Venice in 1491, when it had attached to it the name of Johannes de Keetham, which according to Prof.

Sudhoff is a corruption of Kircheim. It is remarkable as being not only the first illustrated medical book, but also as being the best-illustrated work that had hitherto appeared.

The second edition, which was published in 1493 and is here reproduced in facsimile, differs from the first by containing among other additions the "Anathomia" of Mundinus or Mondino da Luzzi.

The "Fasciculus" passed through many editions, of which thirteen are known to Dr. Singer. The last appeared at Venice in 1522. A belated edition is said to have been published in the seventeenth century, but Dr. Singer has been unable to verify its existence.

Of the two volumes before us, the first contains a commentary on the "Fasciculus," including a discussion of its editions, art, language, sources, and influence, as well as a complete translation of Mondino's work. An atlas of illustrative figures from manuscripts and printed sources with explanatory legends is appended.

The second volume consists of a facsimile of the second edition of the "Fasciculus," and contains, in addition to the text, ten full-page illustrations including one in colour.

The illustrations comprise, among others, figures of the vein man, the wound man, and the zodiacal man, but those most worthy of attention are the frontispiece representing Petrus de Montagnana, the professor of Padua, seated at his desk surrounded by his books, with his waiting-room containing three patients in the foreground; a figure of a puerperal woman remarkable for being the earliest instance in a printed book in which an organ of the body, in this case the uterus, is drawn from the object; and a dissection scene which forms one of the earliest examples of printing in colours.

The "Anathomia" of Mundinus, who has been called the "Father of Modern Anatomy," represents the principal item in the "Fasciculus." In spite of its elementary character and numerous inaccuracies, such as the descriptions of a spherical stomach, a five-lobed liver, and a spleen with imaginary channels evacuating the black bile into the stomach, the work forms a landmark in the history of anatomy, though, as Dr. Singer points out, it is less a text-book of anatomy than a post-mortem manual. Its errors were doubtless partly due to the fact that, owing to the absence of preservatives, anatomical examination had to be performed very hurriedly. The whole procedure did not occupy more than four sessions, the first being devoted to the abdominal viscera, the second to the thoracic organs, the third to the head, and the fourth to the extremities. Subsequent reforms in anatomy were due to artists such as Mantegna, Pollajuolo, Michelangelo, and especially Leonardo da Vinci, rather than to professional anatomists.

Dr. Singer is entitled to special commendation for his translation of the "Anatomia," which, in view of the nomenclature, corruptness of the text, complexity of style, and confusion of thought and expression, was an unusually difficult task. An archaic style has been adopted in the translation, and most of the anatomical and technical nomenclature of the original has been preserved, the terms being explained in a glossary.

The Methods of Systematic Zoology.

Reform der paläozoologischen Nomenklatur. By Rud. Richter. Koehler's *Nachrichtenbl. f. Geol.* 2, Nr. 1-2. (Leipzig, 1925.)

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 144. Abt. 11: *Methoden zur Erforschung der Leistung des tierischen Organismus.* Teil 1, Hälfte 1, Heft 4 (Schlussheft): *Allgemeine Methoden. Allgemeine Methoden des zoologisch-systematischen Arbeitens: die Nomenklatur.* Von W. A. Collier. Pp. 585-676+xii. (Berlin und Wien: Urban und Schwarzenberg, 1924.) 4.20 gold marks.

THESE two publications are welcome as a sign that some attention is being paid to the rules and methods of systematic zoology in quarters where there was much need of more observance. Most of those who are professional systematists have learned from sad experience the harm that has been wrought by want of thought in these technical details; none the less, many zoologists, often eminent in their own lines, continue to commit the same faults as their predecessors and to sow fresh seeds of future confusion. If authors cannot be made to realise their responsibility, there should at least, as Dr. Richter urges, be some hope of impressing editors and publishing bodies with a sense of their still greater responsibility. A committee of the British Association has for many years tried to do this, with some success no doubt, but evidently not with enough. The fact is that in Great Britain at least, and apparently in most other countries, systematic biology is no longer a "discipline." Our universities provide no training in either its principles or its methods; with rare exceptions the professors are as ignorant as the students. The botanists still retain a tradition of Linnæus, ornithologists and entomologists are forced in self-defence to have some method, but the young man who wishes to describe new species in any other groups is fortunate indeed if he has a competent elder colleague to guide him.

If these wanderers recognised their need they would welcome a brief work covering the field implied in Dr. Collier's title. In his text as it stands they will find some good counsel and some sound directions, but he is

not in all respects a safe guide. He is to be commended when he advises a knowledge of the living animal, when he protests against the dispersal of related material through a multitude of minor museums, or when he condemns those who base new species on the descriptions or figures of other authors without themselves seeing actual specimens. Excellent too is his advocacy of precise measurement and numbers, of a recognised colour-scale, of reasonable citation of references as opposed to a peppering of *loc. cit.* and *ibid.*

Sometimes, however, Dr. Collier is not so satisfactory, and occasionally he is actually misleading. The rules of the International Zoological Congress for the placing of figures are good, but need supplementing for the Invertebrata. There is, for example, a recognised way of orienting figures of various echinoderms. A warning is needed against filling a plate with figures lit from different points of the compass—a piece of carelessness that is as irritating as it is inartistic. Reference-letters affixed to drawings are better than nothing; but there is usually plenty of room for the whole word, and its use saves much time. Though many zoologists lessen the value of their work by giving some vague or inaccurate name to their material (*e.g.* "the common sea-urchin"), it scarcely seems necessary to rule that a complete and personally verified synonymy should be prefixed to every systematic note. It is frequently enough to refer to some clear and accessible description and figure. Still, even pedantry is preferable to a lack of precision, for experience shows that a name unsupported by evidence is of little value. Dr. Collier is entitled to use the expression "Trivialnamen" for vernacular names, but it seems a pity to do so, seeing that in the Linnæan system of nomenclature the *nomen triviale* is the second component of the *nomen specificum*, the first being the *nomen genericum*. The few remarks on type-specimens are not free from error. The erroneous definition of "paratype" is particularly unfortunate; that of metatype is incomplete; "homotype," which was preoccupied, has long been replaced by "homoeotypé," but it is little needed. Nothing is said about the subsequent selection of holotypes and genotypes, although this is one of the most important and most difficult questions for a systematist.

Apart from these details, important as they are in a handbook of practice, the whole of Dr. Collier's work seems to be weakened by what may be called a topsyturvy philosophy. Quite correctly he divides systematic work into analysis and synthesis, the analysis consisting in the discrimination of units and their precise description in every aspect, the synthesis which follows being the building up of these units into the hierarchy of systematic categories. As a method of research this

has very much to commend it, and the author could have made a still better case for it had he paid any attention to phylogenetic inquiry, especially that undertaken by palæontologists. But this synthetic method cannot be applied to the practical work of description and exposition; here a fresh analysis is needed. Nevertheless, directions are given for the construction of a system from below upwards, and there are many expressions which seem to imply that the definition of each category should summarise the characters of all its constituent inferior categories.

This method consistently carried out would break down of its own weight. Surely the method most natural to the human intellect is the old logical series of definitions *per genus et differentiam*. Here one begins at the top and gradually works downwards by repeated subdivision. There is no good reason as yet for discarding so clear and concise a method. Nowadays we find some authors establishing new genera or species without any diagnosis at all, and other authors introducing into a wordy description abundance of matter as unnecessary as the statement that a new species of *Equus* has four legs and a head. Had Dr. Collier explained the construction of an old-fashioned diagnosis he would have done a useful service and might have spared a good deal of less practical discussion. His work as it stands is disappointing. F. A. BATHER.

A Register of Harrow School.

The Harrow School Register, 1845-1925. Second Series. In 2 vols. Edited by J. H. Stogdon. Vol. 1: 1845-1885. Pp. xi+472+113. Vol. 2: 1885-1925. Pp. xi+442+113. (London: Longmans, Green and Co., 1925.) 15s net each vol.

TWO big volumes full of names, a fireside, and an editor who requests a notice of the book: where shall we begin? A list of distinguished Harrovians might be attempted, but NATURE would never print it and we should annoy some we forgot to mention. The worst of books like these is that it is impossible to do anything straightforward with them. One is always being side-tracked by something which catches the eye as one turns the pages. What about the editor of the book himself, what sort of fellow is he? Doubtless a clerkly man, but he must have a great love for his school to undertake the colossal task of this compilation. There is his name on the title page, "*J. H. Stogdon*, Member of the Stock Exchange." Now for the index: there he is again, 1889/3. Back to that term in the book: there is his name under that of his headmaster, *Bishop Welldon*—just a seven-line entry, which reveals that at school he was captain of cricket and winner of public schools rackets; that he got his "blue" at Cambridge for both

these games; and that he served with the R.N.V.R. in the War—a man we should like to know.

This is the way one reads a register, but it is scarcely a "review." Let us try what Church and State can offer. Five Harrovians, including the Prime Minister, are in the present Cabinet. There were two in the last one, which says something for the breadth of view taken from the Hill. The *Archbishop of Canterbury* is an Harrovian and a governor of the school. The latest and youngest addition to the Episcopal bench, *Dr. E. A. Burroughs*, is another Harrovian. Generals *Smith-Dorrien*, *Lawrence*, and *Lord Horne of Stirkoke*, also a governor of the school, represent Harrow in the army, as does *Sir Gerald du Maurier* on the stage. *Dr. Walter Leaf*, combining classical scholarship with finance, is equally renowned in each. *Col. the Hon. F. S. Jackson, M.P.*, is even better known for his cricket than for the minor interests indicated in his style, though he raised and commanded a battalion in the War and is chairman of the Conservative and Unionist Central Association. "A Gentleman's A-bowling" is a song which every Harrow boy knows and sings.

Of the nine fellows of the Royal Society whose names appear in the Register, *Lord Rayleigh* is the most famous Old Harrovian. *Sir H. K. Anderson, F.R.S.*, who now represents science on the governing body, is master of Caius College, Cambridge. At Oxford, *Dr. F. W. Pember*, Warden of All Souls, stands for Harrow and classical learning. This reminds one that *Dr. Godley*, the recently lamented Public Orator at Oxford, came from Harrow. So too did *Calverley*, but Godley had all his wit and more stability: at least he did not "migrate," as the Register so kindly puts it, from Balliol to Christ's.

Let us look up Godley. There is his name: came in 1869/1, while *Henry Monagu Buller*, the late Master of Trinity, was headmaster. What schoolfellows Godley had! The following names occur in the year of his entry: *William Henry Grenfell (Lord Desborough)*, chancellor of the Primrose League, president of the London Chamber of Commerce, chairman of the Thames Conservancy Board, who in his youth was president of the O.U.B.C. and O.U.A.C., swam Niagara and stroked an eight-oared racing boat across the Channel; *Walter Hume Long (Baron Long of Wraxall)*, who was in succession Secretary and afterwards President of the Local Government Board, President of the Board of Agriculture, Chief Secretary for Ireland, First Lord of the Admiralty and Secretary of State for the Colonies; *Walter Sydney Sichel*, barrister and author; *A. J. Webbe*, for many years captain of Middlesex Cricket Club; *A. S. Hewlett*, who left missionary work at home to minister to the lepers in Japan; *G. F. Chance*, at one time chairman of Chance Bros. and Co. and high

sheriff of Worcestershire; *P. N. Evans*, whose brilliant career as a consulting chemist was cut short by death in 1893; *H.R.H. The Duke of Genoa*, admiral in the Italian Navy, who was offered the crown of Spain while still at school; and *William Dodge James*, one of the first explorers of Somaliland. A notable year, one may say; but, in fact, it is an average one: at least, it was taken at random.

The Register reveals that, in 1845, the number of boys in the school was about half of the present one, which is about 650. Although *John Lion*, the pious founder, received his Charter from Queen Elizabeth, it was not until the early years of last century that the school outgrew the original buildings. In 1880 the boarders could all be accommodated in the houses of four "dames," whose names are recorded in the Register. *Dame Armstrong's* house has recently been pulled down to clear a site for the war memorial buildings which now approach completion. Nearly all the fame of Harrow has been won since the days of *Sheridan* and *Byron*.

It is worth while to consider the reasons for the success which seems to fall to the lot of Harrow's sons. "Influence," the sceptic may say: well, that counts for much, where the parent knows his world and exercises good judgment. Wealth? No, it is nearly true that the less money a man has, when his education is done, the better off he is. Scholarship? No again, so far as schooling goes. We are nearer the mark when we hazard freedom of thought and the absence of early pressure on immature minds. But the real secret lies in the spirit of service, for the leaders of men will always be chosen from those who have proved themselves willing to give of their best without thought of reward. This is what British public schools stand for, and it is the happiest augury for Britain in these distressful times, that there is growing up a whole host of secondary schools with the same ideals.

Unknown Egypt.

Ministry of Finance, Egypt: Survey of Egypt. Geology of Egypt. Vol. 1: The Surface Features of Egypt, their Determining Causes and Relation to Geological Structure. By Dr. W. F. Hume. Large 8vo. Pp. xliv+408+122 plates. (Cairo: Government Publications Office, 1925.) P.T. 50 (10s. 3d.).

THIS is a study of the conditions of a region which, though easily accessible, is not known to more than a dozen visitors beyond its mere fringe. Of the thousands who go up and down the Nile, not one in a year goes a march into the high desert. The two hundred views here are a joy to any who know the glorious spaciousness and scenery of the wild, and the

many questions that arise in trying to visualise its history. Eocene hills capped with crystallised calcite, or mountains with Tertiary basalt tops; the torrential gravels high up, with boulders which pounded the *ostræa* until it grew shells an inch thick; the collapsed strata dropped four hundred feet into caverns which fed the deep Nile gorge; all these are alluring prospects. The subjects discussed in this volume are naturally more physical than stratigraphic, as dealing with the surface conditions, and in several directions further experiment is needed to solve questions. After an outline of the past work by various nationalities, the variations of temperature are stated as leading to scaling of the rock, often under a difference of 50° C. The effect of this in flaking away architraves when ancient roofing is lost, might well be added.

An important chapter is that on the formation of sand dunes, and on sand erosion. The various types of dune are described, the size up to 30 metres high, the advance of 10 to 20 metres yearly, and the means of arrest. There does not seem to be a known cause for the difference between the ridge dunes, up to 50 or 100 miles long, and the rounded crescent dunes. No doubt one is favoured by a uniform direction of wind, the other by shifting winds which scour round the convexity, but it is not clear how such types begin. A beautiful example of seven parallel ridges, about a quarter of a mile apart, with grassy plains between, might be quoted from the south of Behnesa. The formation of oases is attributed to wind scour, but it is hard to imagine wind scooping out more than 500 feet depth of rock with steep sides, as in the Fayum; it looks more as if seepage had dissolved away lower strata of Eocene limestone into the adjacent Nile gorge, when that was empty to many hundred feet below the present level.

The action of rain is considerable, for though it is rare, the sudden amounts are violent, in the absence of vegetation. The formation of limestone caves is noted; the cisterns natural and artificial are described, some holding up to 500 tons. Forms of denudation on different kinds of rock are finely illustrated. The underground water is largely in the porous Nubian sandstone, which supplies the oases, and can be tapped by wells 250 feet deep in the intervening desert. Deep water supplies, independent of the Nile, are found at 150 to 300 feet, and now supply the larger cities. Frequent discussion has arisen about the black films formed on rocks and stones. These are stated at some length, referring to the sandstone rocks, loose flints, large siliceous nodules, and the granite rocks washed by the Nile. The colour is due to iron and manganese; these are supposed to be dissolved by the dew and brought to the surface by evaporation; but a difficulty is that such colouring is seen on flints which have no

depth to supply the colour. A ground-water source is also stated, and thought probable. The strong tendency of manganese elsewhere to form dendritic crusts, should be considered in this connexion. Another mode of surface action, which is not noticed, is the hardening of limestone superficially, while it crumbles away inside, thus forming a hollow box. Similar internal crumbling—or possibly sea action—is seen in the sentry-box caves formed in the red granite of Sinai. The natron lakes, soda supplies, and soil analyses are also fully dealt with.

There are several other subjects noticed in the 219 pages, and it is clear that there are many matters which need more study, as on scarcely any point is there finally conclusive information. In spite of a bibliography of 912 works, Egypt is still an open field for investigation in many lines, and Dr. Hume obviously would welcome scientific work auxiliary to his department. The facilities of this volume are admirable; the bibliography of 68 pages has a subject index of 10 pages; and the whole 314 pages have a remarkably full index of 94 pages. A geological map on 1:2,000,000 is supplied at the end, and there are half-a-dozen detail maps beside the wealth of photographs. The work bears imprints of 1922, but was delayed in issue until 1925. We hope that we may soon see the next volume, and that the Nile borders may be described as well as the desert.

FLINDERS PETRIE.

Our Bookshelf.

- (1) *The Fundamentals of Statistics*. By Prof. L. L. Thurstone. (Experimental Education Series.) Pp. xvi+237. (New York: The Macmillan Company, 1925.) 8s. 6d. net.
- (2) *Statistical Methods for Research Workers*. By R. A. Fisher. (Biological Monographs and Manuals.) Pp. x+239. (Edinburgh and London: Oliver and Boyd, 1925.) 15s. net.

MODERN statistical methods are now used in such widely different spheres of activity that it is natural that several books on the subject should be produced to meet the needs of the various persons concerned. It is of interest to notice that these books, being of the textbook variety, usually assume an air of certainty with regard to some things which are still almost within the region of controversy. This becomes the more obvious as the subject-matter becomes more advanced.

(1) Turning to the two books before us, we find that Prof. Thurstone has set himself the task of providing an elementary book on statistics for students of psychology who have little mathematical knowledge. The book is about as elementary as it can be, and it assumes that the reader is so poorly equipped as to need to have the graphical expression of a straight line and the most elementary aspect of the binomial series explained. It will, however, enable these non-mathematical students to follow, in a reasonable way, results obtained by others and expressed in terms that would

be meaningless without some help such as this book gives. A good many elementary books of this kind have been published in recent years in the United States, and this is one of the best of them.

(2) Mr. Fisher's book is written for a more advanced type of reader, and it has much to commend it. It treats of the interesting and important subject of small samples in statistical work; it has originality; its author is full of ideas, and its appearance is all that can be desired. But, unfortunately, the book suffers from an introductory chapter which seems unnecessarily hard to follow, and from the difficulty of the subject, which has, we fear, often prevented Mr. Fisher from writing down to his reader. The book is intended for biological research workers, and it is apparently assumed either that they already know sufficient of the theory to accept, without proof, the methods given, or that they will adopt these methods on Mr. Fisher's authority. A statistical "research worker" may be willing to dispense with rigid mathematical proofs when it can be seen from several arithmetical examples that a method carries its own justification, but in the present work the absence of proof goes rather far, and we fear that readers with little knowledge of the most recent statistical work will find the book as a whole difficult to follow, while those unfamiliar with the terms used in biological research work will have trouble with some of the examples.

In many places throughout the book a reader may hesitate, wish perhaps that he could share Mr. Fisher's confident assurance, and then find himself wondering whether deep down under much of the theory about which Mr. Fisher is so sure, there may not lurk the assumption that we can approximate to the whole population from a sample in a way that resembles the theory of "inverse probability" which he "wholly rejects."

It seems to us probable that the book will be read as much by statisticians who wish to study Mr. Fisher's methods and views as by those research workers who merely went to apply the methods he describes. Such readers will find so much that is interesting, suggestive, and useful that they will forgive the weaknesses we have tried to indicate.

The Theory of Electric Cables and Networks. By Dr Alexander Russell. Third edition. Pp. xii+356. (London: Constable and Co., Ltd., 1925.) 24s. net.

WITH the rapid growth of electrical distribution, and the increasing size of networks, the most economical design of the distributing system is becoming more important every year. The third edition of Dr. Russell's well-known book will therefore be welcomed by all engineers who are concerned with cable manufacture or with the business of electric distribution. This edition does not differ very much from the second edition, which was published in 1919, nor is it necessary that it should, for the book deals mainly with fundamental principles.

The tables of standard sizes of wires and cables and of the electrical and thermal constants of materials are of great value, and the discussion in the second chapter of the mechanical and electrical properties of copper is one of the most complete that is to be found in any standard text-book. Equally thorough is the study of insulativity and insulating materials. The treatment

of distributing networks and the determination of the fault resistance of such networks is especially good. The author has himself contributed largely to the technical literature of this subject, and his method of finding fault resistance is well known to all distribution engineers.

Dr. Russell is also a well-known authority on dielectric strength. This subject is of growing interest on account of the higher pressures at which cables are being operated. The heating of cables is discussed, but in any future editions of the book it is hoped that reference will be made to the heating of buried cables and to the extensive researches that have been carried out in recent years under the auspices of the Electrical Research Committee. The chapter on electrical safety valves, also, should include some reference to the lead peroxide arrester, which is now being used so largely in the United States.

The chapter on lightning conductors contains material which is not available except in the *Proceedings* of learned societies, and the new appendix on the interesting problem of the most economical site for a power station is of special value in view of the growing importance, economically, of the electrical aspect of this problem. This book is well known as a standard textbook on the theory of electrical cables and networks, and should be on the shelves of all cable manufacturers and distribution engineers.

The Journal of the Institute of Metals. Vol. 33. Edited by G. Shaw Scott. Pp. xii + 710 + 15 plates. (London: Institute of Metals, 1925.) 31s. 6d. net.

SCIENTIFIC readers of the new volume of this Journal will probably turn first to the May Lecture, in which Prof. H. A. Lorentz deals in a most fascinating manner with the most recent knowledge of the motion of electricity in metals, including the determinations of the velocity of moving electrons in a conductor, and with the phenomena of super-conductivity. The whole lecture is a model of reasoning and exposition. The papers contributed to the Institute cover a wide range, the properties of the various alloys of copper occupying as usual a considerable proportion of the space. Problems of corrosion are dealt with in several papers, and it is satisfactory to notice that the apparently irreconcilable positions taken up by different investigators have now been examined in an impartial spirit, and an agreed statement has been issued, so that further experimental work can proceed without the atmosphere of controversy which has so long enveloped the subject. An important practical paper describes experiments on the production of castings of aluminium alloys with greatly diminished porosity, the method used being to free the alloy from dissolved gases by bubbling nitrogen through the liquid just before solidification, afterwards remelting. The inert nitrogen washes out the gases which give rise to blowholes, and sound castings result. This method has also been applied with success to other alloys. More than half of the volume is occupied by abstracts of work published elsewhere, and this section is invaluable to the metallurgist, the abstracting being done with remarkable thoroughness, so as to include research in pure physics and chemistry wherever it touches metals. The arrangement is clear, and the method of presentation is attractive.

Abbeys. By Dr. M. R. James. With an additional Chapter on Monastic Life and Buildings, by Dr. A. Hamilton Thompson. Pp. x + 154 + 107 plates + 13 plans. (London: Great Western Railway, Paddington, 1925.) 5s. net.

It is only fair to warn the unwary that this book is not a treatise on abbeys in general, or a comprehensive survey of the abbeys of Britain. It deals only with those abbeys which are on or accessible from the Great Western Railway system. There is no hint of this on the title-page, except in the publisher's imprint, which many will not notice. It is, in fact, a glorified guide-book; but a guide-book of a type which we wish were more frequent. Nearly every building is illustrated in one or more photographs, excellently reproduced. In addition, several examples of the priceless manuscripts which were produced by the monks of the abbeys are given in colour. The letterpress of the Provost of Eton is to a great extent, though not entirely, a compilation. As he explains in his preface, he has visited most of the buildings, and to his authorities he has added something of his own. Not only are the buildings adequately explained for the needs of the visitors, but the author has also brought out in each case the relative importance of each and of the community to which it belonged. The list of abbeys classified according to religious orders will be found a great convenience. Prof. A. Hamilton Thompson has contributed an admirable chapter on monastic life. The book is a remarkable production at so low a price.

Summation of Series. Collected by L. B. W. Jolley. Pp. xi + 232. (London: Chapman and Hall, Ltd., 1925.) 13s. 6d. net.

A COMPREHENSIVE collection of series and their sums would be invaluable to the university teacher, the research worker, or the technician, according to the principle guiding the selection, but an attempt to cater for all parties must necessarily spell failure. The present volume, containing about seven hundred series, is well arranged and includes individual types easy of reference. The series are set out clearly on one page, and the sum on the page facing. In spite of the compiler's intentions, we believe the collection will be of value mainly to the not too advanced student. Fourier series, Bessel functions, and elliptic functions are treated in cursory fashion, although quite a number of Fourier series are classified under the heading of trigonometric series. The general expression for Fourier coefficients does not appear to be given. It is eminently desirable that the limits of the variable within which the series is a valid representation of its "sum" should be systematically stated—a dangerous omission if the collection is intended for the use of the technician.

Life: a Book for Elementary Students. By Sir Arthur E. Shipley. Second edition. Pp. xvi + 204. (Cambridge: At the University Press, 1925.) 6s. net.

It is a pleasure to find that Sir Arthur Shipley's little book, which was reviewed in *NATURE* of July 5, 1924, p. 6, has been so much in demand that a second edition has already been called for. A few minor changes have been made.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Selective Action of Polarised Light upon Starch Grains.

IN a recent note (*Annals of Botany*, 39, 651, 1925) Prof. Neilson Jones has criticised our statement (*Proc. Roy. Soc.* 97 B, 250, 1924) that starch grains are selectively hydrolysed by polarised light in the presence of small quantities of diastase. Prof. Jones is under a misapprehension when he says that we accepted the frilling or serration of the grains as evidence of hydrolysis. We did not do so, for what we observed was the complete disappearance of the starch grains when illuminated with polarised light, slight serration only occurring in heterogeneous light. Further, after complete hydrolysis of the starch grains by polarised light, the solution deposited crystals which reduced Fehling's solution.

If Prof. Jones is correct in saying that the serration of the starch grains may be caused by other influences, he removes the last difficulty from our minds, namely, the slight change we observed with heterogeneous light. This may now be attributed to those secondary effects and not to incipient hydrolysis.

As the principal cause of these secondary effects Prof. Jones cites the pressure of the cover slide, but this naturally cannot account for the disappearance of the starch grains and their conversion into crystalline compounds which reduce Fehling's solution.

If any doubt remains on this point, we are now able to say that when starch grains in pure water are placed in a Petrie dish or in a flask and illuminated with a strong beam of polarised light, they are hydrolysed. The breaking down of the grains is obvious when they are examined microscopically, and the aqueous film on evaporation deposits crystals which have been found to reduce Fehling's solution.

Although in our paper we refrained from entering into the theoretical explanation of the phenomenon, it is obvious that it must be connected with a selective absorption of polarised radiant energy by the optically active starch grains. In this connexion, the observations made by Liebisch and Rubens of the different absorptive power for polarised and ordinary infra-red radiation of optically active crystals are of great significance (*Berl. Ber.*, 1919, 198 and 876).

Prof. Jones makes no mention of other observations which confirm our results. These observations may be divided into two classes, namely, those which had been made previously to the publication of our paper and may be explained by our results; and those observations which have been definitely undertaken as the result of our work. Amongst the first group we may quote the work which was carried out by Knauth on the influence of moonlight on the photosynthetic processes of certain plankton. His results are quoted at length by Kofoid (*Bull. Illinois State Labs. Nat. History*, 8, 305, 1908). Knauth found that the relative efficiency of moonlight and sunlight was about 2:9, and Kofoid considers this ratio to be smaller than the maximum and above the average. The relative intensities of sunlight and moonlight were given by Zollner as 618,000:1, and it would seem, therefore, that for equal intensities moonlight is more than

100,000 times as efficient as sunlight. Kofoid followed up this work and established an undoubted correlation between the maxima in the seasonal variation of these micro-organisms and the period of the full moon. This phenomenon may well find an explanation in the fact that moonlight is on the average polarised to the extent of 10 per cent.

As a second example of the well-known influence of polarised light we may mention the peculiarly bad effect on the eyes of the light scattered from a snow field, a phenomenon which is painfully familiar to mountaineers. The high polarisation of such light is well known.

We may also refer to Padoa's observation that crystals of *o*-nitrobenzaldehyde are selectively decomposed by polarised light, provided that the crystals are correctly oriented to the plane of polarisation (*Atti R. Accad. Lincei*, 28, 372, 1919). Other similar phenomena are probably too well known to need mention, such for example as Weigert's observations of the effect of polarised light on the photographic plate.

Of the second group we may quote Morrison's proof of the selective action of polarised light on the growth of luminous bacteria, *e.g.* *Photobacterium phosphorescens* (*Science*, 61, 392, 1925), an observation which has been confirmed by Macht and Hill of the Johns Hopkins University with *B. coli* and *B. typhosus* (*Proc. Soc. Exp. Biol. and Medicine*, 22, 474, 1925). Mention may also be made of Bryant's observation that the polarised light from the moon has a selective action in causing the putrefaction of pieces of fish (*J. Chem. Ind.*, 42, 681, 1924).

Then, again, we may mention the observation by Macht and Hill that the hydrolysis and fermentation of cane sugar by *Saccharomyces cerevisiae* is selectively promoted by polarised light (*Proc. Soc. Exp. Biol. and Medicine*, 22, 474, 1925), and lastly, we have Macht's direct confirmation of our own work (*ibid.* p. 473). In the latter experiments, starch solutions containing definite quantities of taka-diastase were exposed to polarised and non-polarised light. The conversion of the starch into sugar took place more rapidly in polarised light than in non-polarised light of the same intensity, and, as Dr. Macht says, the results he obtained fully corroborate our observations.

Prof. Jones says that he has been unable to repeat our observations, and describes his method of observation with a pointolite lamp. We would suggest that the presence of gelatine in his experiments is very undesirable. If we are correct in our assumption that the phenomenon is due to the selective absorption of polarised radiation, then no other inert colloid must be present, as such may completely interfere with the progress of the particular phenomenon to be observed. If an inert colloid be added, then care must be taken that it does not protect the starch by having the same absorptive power towards radiant energy, and further, that it scatters and polarises radiant energy of the correct wave-length. In short, the extraneous colloid, if it is not in correct tune with the starch and its own particular enzyme, will act as a negative catalyst of the reaction. These correct conditions are undoubtedly secured in the natural enzyme, and it is very questionable whether an entirely foreign colloid such as gelatine conforms to these conditions. This most probably accounts for Prof. Jones's negative results, especially in view of the confirmatory evidence we have previously mentioned.

E. C. C. BALY.

ELIZABETH SIDNEY SEMMENS.

The University, Liverpool, and
Bedford College, London,
November 6.

The Blindness of Cave-Animals.

It is with much diffidence that I take up my pen to reply to the letter of Sir Ray Lankester, which appears in *NATURE* of November 21. I have been brought up to venerate Sir Ray as the leader of British zoology, and if I cannot claim him as my zoological parent, I can at least regard him as my zoological uncle, for between him and my teacher and friend Adam Sedgwick there always reigned complete sympathy and co-operation.

Sir Ray blames me for having, in a chapter entitled "Zoology" in a book on "Evolution in the Light of Modern Knowledge," come to the conclusion that the inheritance of the results of use and disuse has been the main factor in evolution. He says that this idea is not modern but was put forward by Lamarck a hundred years ago. He also says that he thinks that judgment on the value of Kammerer's experiments should be suspended until they have been repeated, for, as he goes on to say, J. B. S. Haldane points out, that in the past critical repetition of similar experiments has been fatal to the conclusions drawn from them.

Sir Ray then goes on to criticise the theory of inherited disuse as applied to the explanation of the blindness of cave-animals, and to put forward a theory of his own in place of it.

Now I should like to say at once, with reference to Mr. Haldane, that when he thinks fit to publish his criticisms in a recognised scientific journal, instead of in the "Annual of the Rationalist Press Association," which no scientific man is bound to consult and which I, for one, never see, it will give me the greatest pleasure to criticise his criticisms.

As I have pointed out in a review which appears in *NATURE* of November 28, it is not the lack of evidence which has prevented Lamarckian experiments from bringing conviction, but it is the obsession of minds with the Weismannian complex which has stood in the way and which has caused any attempt, however flimsy, to explain Lamarckian results away, to be accepted as disproving them. For a recent example of this spirit I may refer readers of *NATURE* to the issue of June 2, 1923, in which a leading English Mendelian, in endeavouring to discredit the evidential value of Kammerer's celebrated specimen of *Alytes* with the horny pad, says: "but on the palm of *Alytes* they [the horny callosities] would be as unexpected as a growth of hair on the palm of a man." My comment on this statement is that I have preserved in my laboratory the fore-arms of four male frogs—the first four that I looked at—all of which show the extension of the pad to the palmar surface of the hand.

As Sir Ray Lankester, perhaps, has scarcely been able to keep up with the recent literature bearing on this controversy, he is probably unaware that Kammerer's critical experiments, namely, the hanging on to posterity of the effects of the reaction of the skin to coloured surroundings, have been repeated by Durkhen on totally different animals, with the most meticulous care, and that Durkhen's results entirely confirm Kammerer's conclusions. Durkhen's work again has been repeated by Fr. Brecher of Vienna and confirmed.

I am sure that Sir Ray would agree with me that the evidence for evolution is mainly derived from three sources, namely, systematic zoology, palaeontology, and embryology. I find that the most distinguished systematists and palaeontologists are openly accepting the Lamarckian view; as an embryologist, I myself have been driven to it; and when the experiments just alluded to are taken into account, would Sir Ray not admit that the most

modern knowledge on the subject of evolution favoured Lamarck's hypothesis even though that theory was put forward a hundred years ago?

I now come to the special case of the blindness of cave-animals. I am well acquainted with the hypothesis which Sir Ray advances to explain this blindness, namely, that animals with congenital eye-defects stayed in the dark whilst their more gifted brethren escaped into the light. Did I not derive a large part of my early attraction to zoology from Sir Ray's inspiring writings? Nevertheless, I consider Sir Ray's hypothesis unsatisfactory for the following reasons:

(1) The only case in which the cause of blindness in a cave-animal has been analysed is that of the cave-newt, *Proteus*. Here, as Kammerer has shown, the cause of blindness is not congenital defect, but lack of stimulus to growth, for *Proteus* can, under proper conditions, produce a perfectly normal eye. Whatever hesitation may remain about accepting Kammerer's results in other matters, there can be no dubiety about his results on *Proteus*. In common with other zoologists who attended the special meeting of the Linnean Society in May 1923, I saw these large-eyed specimens of *Proteus*, the most wonderful specimens in my judgment which have ever been exhibited to a zoological meeting.

(2) Congenital eye defects, of course, occur, and I believe that before long we shall discover the causes of them. But they are correlated with general weakness and sickness of constitution. Microphthalmic rodents, for example, rarely survive. It is most unlikely that such weakly specimens would give rise to a new species.

Sir Ray says that there is no evidence that the eyes of animals bred in the dark diminish in size, and he cites experiments by Payne quoted by Haldane. Payne bred *Drosophila* for 75 generations in the dark and observed no effect: 75 generations of *Drosophila* would occupy a little over two years. In an article on "The Inheritance of Acquired Characters," contributed to *Science Progress* in 1921, I showed that there was evidence that the eyes of gammarids, which had lived in pools in deserted salt mines in Austria for two hundred years, had undergone definite reduction, and that this reduction was totally unlike what was met with in congenital eye defect.

E. W. MACBRIDE.

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Carnot's Cycle and Efficiency of Heat-Engines.

THE cycle proposed by Dr. J. S. Haldane (*NATURE*, August 29, p. 326) as a standard of comparison for steam engine performance can be shown quite readily on a temperature-entropy chart, and thus be directly compared with the Carnot cycle and also with the Rankine-Clausius saturated steam cycle, and the relative efficiencies of the three cycles can be viewed at a glance.

Starting first with water at the lower temperature T_2 , heat is added until all the water has been evaporated into steam at a temperature T_1 , and in a closed space. This process is shown on the chart (Fig. 1) as the constant volume line abc , and the heat added is shown by the area $fabce$. Then follows adiabatic expansion represented by cd down to the lower temperature T_2 , and finally isothermal condensation along da , with rejection of heat measured by the area $edaf$.

The efficiency of the cycle is therefore

$$\frac{\text{area } abcd}{\text{area } fabce} = \frac{A}{A+B}.$$

On the ordinary steam temperature-entropy chart, *ag* being the water line, the line *abc* divides the whole area *fagce* into external energy *E* and internal energy *A + B*. The Rankine-Clausius cycle being *ag, gc, cd, da*, its efficiency is $\frac{A+E}{A+B+E}$, and this is obviously greater than the Haldane cycle efficiency, since the area *E* bears a greater proportion to the area *A* than to the area *A + B*.

The Carnot cycle is simply *ah, hc, cd, da*, and its efficiency is $\frac{A+E+D}{A+B+E+D}$, which, for a similar reason, is greater than $\frac{A+E}{A+B+E}$ for the Rankine-Clausius cycle.

As a numerical example, take 1 lb. of water at a temperature of 140° F. corresponding to 3 lb. per sq. in. absolute back pressure, and let this be evaporated into steam at 341° F. corresponding to an absolute pressure of 120 lb. per sq. in.

From steam tables, the total heat in 1 lb. of water at

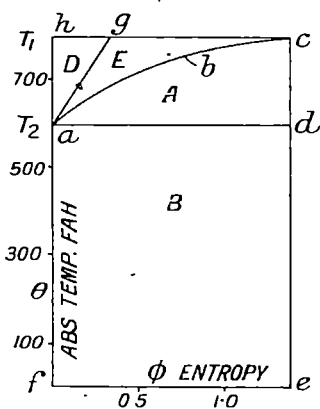


FIG. 1.

341° F. above 32° F. is 1186 B.T.U., the external energy *E* is 82.1 B.T.U., and latent heat is 874 B.T.U. Hence

$$A + B = 1186 - (140 - 32) - 82.1 = 995.9 \text{ B.T.U.}$$

To find area *B*, first calculate *ad* or ϕ_2 .

$$\phi_2 = \log_e \left(\frac{341 + 460}{140 + 460} \right) + \frac{874}{341 + 460} = 1.3803.$$

Thus

$$\text{area } B = 600 \times 1.3803 = 828.18 \text{ B.T.U.}$$

and

$$\text{area } A = 995.9 - 828.18 = 167.7 \text{ B.T.U.}$$

The efficiency is therefore $\frac{167.7}{995.9} = 16.7$ per cent.

For the same data, the Rankine-Clausius efficiency is

$$\frac{A+E}{A+B+E} = \frac{167.7 + 82.1}{995.9 + 82.1} = 23.1 \text{ per cent.},$$

and the Carnot efficiency

$$= \frac{A+E+D}{A+B+E+D} = \frac{ah}{fh} = \frac{801 - 600}{801} = 25 \text{ per cent.}$$

The chart is drawn approximately to scale for the above data. The higher efficiencies of the two last-named cycles are simply due to the addition of a large proportion of heat at the higher temperature. The Haldane cycle omits this and is therefore of lower efficiency.

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The London Skull.

IN his most interesting article on the London Skull, in NATURE of November 7, Prof. G. Elliot Smith states that "The deposit in which the human remains were found forms part of the third (or lowest) terrace of the Thames containing the characteristic late Pleistocene fauna . . . presumptive age [of the skull] must be assumed to be later than the Mousterian phase of culture."

On the Geological Survey Maps (one-inch sheet 256 North London; six-inch London 7 SE) the site is shown as Middle Terrace. In the memoirs dealing with the area it is stated that this terrace has yielded late Acheulian types of implements, and that from its surface, overwhelmed by Coombe Rock or Trail, numerous Mousterian implements have been found above, in, and below London. Moreover, the various mammals mentioned by Prof. Elliot Smith as occurring at the Leadenhall Street site are mentioned among those found in this terrace ("Geology of the London District," 2nd ed., 1922, pp. 49-70; "Geology of North London," 1925, pp. 41-49).

If this view of the age of the deposits in which the skull was found is correct, its Neanderthal character, so far from suggesting "the possibility of the survival into Aurignacian times (in Britain) of a stray representative of the species *neanderthalensis*," is quite normal. Being responsible for the maps and memoirs alluded to, I should be glad to know on what grounds Prof. Elliot Smith assigns the deposit to the Low Terrace instead of the Middle, thereby involving himself in a difficulty as to the human species represented by his skull.

C. N. BROMEHEAD.

Geological Survey Office,
14A Parliament Street,
York.

I AM very grateful to Mr. Bromehead for directing my attention to the evidence for identifying the London Terraces. In reply to his query on what grounds I assign the deposit at Lloyd's to the Low Terrace instead of the Middle, I can only say that I have never claimed any competence to decide the geological points at issue; but, as I have already stated in public and in print on several occasions, have taken the opinions expressed when the ulna of the woolly rhinoceros (from the same level in the blue clay at Lloyd's) was exhibited at a meeting of the Zoological Society last March.

The decision of the age of the deposit, concerning which several geologists have written to me, has become of such crucial importance that last week the matter was referred to Prof. Boswell for his advice.

I need scarcely say that if Mr. Bromehead's opinion (which in private correspondence Prof. Sollas and Mr. Reid Moir had already suggested to me) should prove correct, it will facilitate my task of interpretation. For the London skull conforms much more nearly to the Neanderthal type than to the form that is usual in *Homo sapiens*. The fulness of the cerebellum, however, is in sharp contrast with the flattened Neanderthal type. The cranium is as thin as that of a modern woman's. In this respect, however, it agrees with the Neanderthal cranium found in 1911 at La Quina. Moreover, as Prof. Wingate Todd has pointed out (*Anat. Record*, vol. 27, 1924, p. 245), thickness of skull is so variable a feature as to have no decisive value as a specific criterion. Hence the points of difference between the London skull and the Neanderthal type are not necessarily significant. So that, if the blue clay can be shown to

be associated with the Mousterian phase of culture, the anatomical evidence can be interpreted more easily than would be the case if the deposit is Aurignacian.

The paradoxical evidence provided by the anatomical features of the skull renders the determination of the geological age a matter of fundamental importance. Hence Mr. Warren Dawson and I have taken the advice of many authorities in the hope of deciding this issue. Since this letter was written, Mr. Hinton, who examined the remains of the woolly rhinoceros and mammoth from the Lloyd's site last March, has again assured Mr. Dawson that "the blue clay in London is quite definitely post-Mousterian."

G. ELLIOT SMITH.

The Collection of Bryophytes by Scientific Expeditions.

MAY I ask the publicity of your columns for a matter concerning a rather limited branch of natural science, but one which we desire to ventilate as widely as possible in scientific circles?

The following resolution, passed unanimously at the annual meeting of the British Bryological Society held at Ross in August last, to a great extent explains itself:

"That it is desirable that in any future scientific expeditions promoted by British or Colonial public bodies, special attention should be given to the collection of bryophytes, the determination of which should be entrusted to British botanists."

The necessity for such a resolution arises from the fact that in most recent scientific expeditions bryophytes have received the scantiest attention or none at all. As an example may be cited the Mt. Everest Expedition, 1924. Although a special request was made that attention might particularly be paid to the collecting of bryophytes, not a single specimen was brought back by the official scientific staff, although at the altitudes at which most of the encampments were made it was obvious that cryptogamic plants might be expected to form far the highest percentage of the vegetation. This is evidenced by the fact that a certain number of cryptogams were individually collected by one of the climbing members of the expedition, and privately transmitted home, and these proved of great scientific interest (*cf. Journ. of Bot.*, 1925, pp. 189, 221)—including a moss from considerably the highest altitude from which any moss has hitherto been collected.

A recent scientific expedition to Australia, the West Australian and Islands Expedition, under Capt. Wilkins, sent out under the auspices of several of the principal scientific institutions and societies of Great Britain and Australia, returned with but a single example of the lower cryptogamous plants—a block of fossil diatomaceous earth. Bryologists have repeatedly the tantalising experience of hearing from returned explorers of the wealth of bryophytic vegetation traversed by them—lantern slides being sometimes especially prepared, for their particular delectation or exasperation, to illustrate the "dense masses of arboreal mosses" through which an expedition passed—only to find that among the botanical collections brought home the bryophytes are conspicuous by their absence.

The older botanical explorers knew better—Hooker in the Antarctic, Spruce on the Amazon, Schweinfurth in Africa, Wallich in Asia, and a host of others—and our knowledge of the world flora and of the factors of geographical distribution has been vastly increased thereby.

The facility of their collection further justifies our claim, since no plants demand less in the way of space or preparation. They simply require drying; and they may be usefully employed in filling up interstices and acting as packing for other specimens.

These arguments might easily be multiplied, but they would make a further demand on your space which would be, I fear, undue, and I hope superfluous.

H. N. DIXON.

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Northampton.

The London Zoological Society's Aquarium.

IN NATURE of November 21, p. 767, in a report of the recent ornithological meeting in Berlin, "E. H." states that the Berlin Aquarium was "the model from which the larger London Aquarium has been built." This is entirely erroneous. Certainly we knew of and had inspected the Berlin Aquarium as well as many others whilst making our plans, but I do not know of any single feature, either mechanical or decorative, which we based on the Berlin Aquarium.

P. CHALMERS MITCHELL.

Zoological Society of London,
London, N.W.8,
November 23.

I AM glad Dr. Chalmers Mitchell corrects an error in my report. I understood that Mr. Boulenger had thoroughly inspected and measured the tanks in Berlin, which to me looked very much like those in the London Aquarium—but as I am not an expert on aquariums, I should not distinguish differences very clearly, and would notice similarities in all modern institutions of that kind. I have never had any doubt that the London Aquarium has great improvements on all others, as it is natural to improve on former establishments of the kind, when building a new one, by making use of the experience of others.

E. H.

Cyclops robustus, G. O. Sars.

Cyclops robustus is given by Prof. Sars as one of the rarer species, and to the best of my knowledge it has not been recorded previously for the British Isles.

Last July several specimens occurred in some tubs outside the biological laboratory at Marlborough College. The tubs in question are kept for the refuse from pond-life study. Some time afterwards, as the result of a fairly prolonged search, several ponds were found in Savernake Forest containing this species.

The reason why this species has not been recorded in the British Isles before must be, I think, that it has been overlooked on account of its resemblance to *Cyclops lucidulus*, Koch. That *Cyclops robustus* is really widely distributed in the British Isles is almost certainly proved by the fact that I found it so far north as Roineval in the Isle of Skye in September last.

It is interesting to note that Prof. Sars in "Crustacea of Norway" (vol. 6, p. 46) states that he has only found this species, in Norway, on the borders of the larger lakes. I have only found it in quite small ponds, if not puddles, especially those containing Sphagnum. Dr. W. Arndt has also found it in ponds in Bulgaria (*Zool. Anzeiger*, vol. 61, p. 298), though his specimens seem to differ somewhat from the original type.

A. G. LOWNDES.

Marlborough College, Wilts.,
November 20

The Nature of Man's Structural Imperfections.¹

By Sir ARTHUR KEITH, F.R.S.

I.

BETWEEN the activities of Archdeacon Paley and those of Élie Metchnikoff lies the greater part of the nineteenth century. At the beginning of that century we find the Archdeacon extolling the perfections of the human body—just as Celsus had done sixteen centuries before him.² By the close of the nineteenth century the alert and fearless brain of Élie Metchnikoff had discovered, or believed it had discovered, that the human body was blemished by many imperfections. The evangelist of this new and startling doctrine approached the study of man's body by an untrodden pathway, one made possible by the advancing science of his day. On his arrival at the Institut Pasteur in 1888, being then forty-three years of age, he set himself to investigate the means by which the human body combats and keeps at bay the swarming hosts of micro-organisms which find a natural habitat in its internal passages and recesses. He saw man's body as a battlefield—the scene of a perpetual warfare—and as his investigations proceeded, the conviction grew on him that the chances of the body's success were imperilled by a heritage of structures which had become out-of-date and useless. In the Wilde Lecture given before the Literary and Philosophical Society of Manchester, on April 22, 1901, he declared that man "was being killed by his intestinal flora," and that his great intestine had not only become useless but was also a positive and continual menace to the rest of his body. He believed that the stomach itself, and also part of the small intestine, could be dispensed with. Early in 1903 appeared "*Études sur la nature humaine*,"³ in which Metchnikoff greatly extended the list of man's structural imperfections.

Between the times of Paley and of Metchnikoff lie three great discoveries, and we must take note of them if we are to understand how it was possible for one to praise the perfection of man's structure at the beginning of the nineteenth century and the other to condemn its imperfections at the end. There was first the discovery that man's body was an aggregate or society of living microscopical units; it was Metchnikoff's fortune to approach the study of man's highly complex body through the simpler societies represented by the bodies of the lower invertebrates; it was thus he came by his discovery that certain units of such societies retain their freedom, thus permitting them to serve as scavengers or phagocytes. In the second place, there was Darwin's discovery; Metchnikoff was a convinced evolutionist. He therefore presumed that the alimentary outfit which served in an anthropoid phase of human evolution must be ill-adapted to deal with the dietary of civilised man. There was in the third place Pasteur's discovery, and so far as Metchnikoff's outlook was concerned, this was the most potent of the three. It was under the influence of Pasteur's discoveries that Metchnikoff came to think that the destiny of man lay in the issue of the everlasting contest which went on

between the living tissues of his body and the invading hosts of micro-organisms which threatened them. It is noteworthy that of the three men—Darwin, Pasteur, and Metchnikoff—who revolutionised in the 19th century our conception of man's body, and of the struggles to which it is subjected, not one of them was a professed anatomist; the anatomist stood too near to the subject of his study to see it in its true perspective.

Twenty-two years have come and gone since Metchnikoff's studies on "*La nature humaine*"⁴ first appeared, and I propose in this lecture to ascertain how far his doctrines of man's structural imperfections and functional disharmonies have stood the test of time. His thesis presumed that Darwin's theory of man's origin was true; that presumption has been supported by every discovery of the present century, and such evidence as we now have justifies us in believing that the rate of man's evolution has been more rapid than has hitherto been supposed.⁵ We realise to-day, more precisely than was possible when Metchnikoff wrote, that the most critical chapter in man's long history opened with the discovery of agriculture, a discovery of but yesterday if we reckon time on a geological scale. Agriculture revolutionised the conditions of human life; it made modern civilisation possible. We have reason to believe that this revolution in the condition of man's life was initiated either in Mesopotamia, Egypt, or adjacent lands not more than 8000 years ago. It is certainly not more than 5000 years ago since agriculture began to be practised in Western Europe. The vast majority of the people of the British Isles, probably 90 per cent. of them, are the descendants of men and women who, 200 generations ago, were dependent on the natural but precarious harvest which is provided by shore, river, forest, and moorland. City life is a new experiment for Europeans; most of us who live in London, if we could go back twenty generations, would find an ancestry which was living on the soil and of the soil; and now the poorest of us can add to our dietary produce brought from the ends of the earth. The alimentary system which was evolved to meet the needs of our primitive ancestors has now to accommodate itself to a modern dietary.

Beyond a doubt civilisation is submitting the human body to a vast and critical experiment. It is not only the alimentary system which is being subjected to new conditions; the bony and muscular framework of our bodies are also being subjected to novel stresses. Of the present manhood of Britain, half earns its bread by muscular labour; the other half lives sedentary lives. Our forefathers when they arrived in Western Europe were hunters; their bodies were unaccustomed to either manual labour or an indoor life; under the

¹ In 1907 Metchnikoff published a further work, of which an English translation appeared in the same year, edited by Dr. P. Chalmers Mitchell, under the title "*The Prolongation of Life*". In this Metchnikoff replied to his critics and produced more evidence in support of his thesis. Sir W. Arbuthnot Lane formed the opinion that the great intestine was a useless and dangerous structure independently of Metchnikoff; so also did Prof. Barclay Smith (see an article on the nature of the caecum and appendix by the present lecturer in the *Brit. Med. Journ.* 1912, vol. 2, p. 1599).

² See "*The Adaptational Machinery concerned in the Evolution of Man's Body*," *NATURE* (Special Supplement), August 18, 1923, p. 257; and "*Concerning the Rate of Man's Evolution*," *NATURE*, August 29, p. 317.

³ The Lloyd Roberts Lecture delivered to the Royal Society of Medicine on November 16.

⁴ See "*Evolution of Anatomy*," by Dr. Charles Singer (1925), p. 50.

⁵ An English translation, edited by Dr. P. Chalmers Mitchell, was published in 1904 under the title "*The Nature of Man*" (Hememann).

stress of civilisation the hunter's body has to serve modern needs. It says much for the adaptability of the human body that it stands these stresses so well as it does. Dr. J. D. Comrie,⁶ on examining 10,000 recruits for the army, found that 363 of them suffered from hernia and 113 from flat foot. Such breakdowns in the supporting system of the body do not occur with this frequency among hunting peoples. Civilisation has laid bare some of the weak points in the human body, but the conditions which have provoked them are not of Nature's ordaining but of man's choosing.

If modern civilisation is making new demands on our bones, muscles, and nerve controls, it is otherwise with another important system of our bodies. As our manner of living increases in comfort, the calls on our heat-regulating mechanism become fewer in number and less urgent in character. Our primitive forefathers lived in the open; their bodies, unhoused and scantily clad, were exposed to sun, rain, wind, and storm. Such a mode of life throws an increasing burden on the machinery which regulates body temperature—on skin, on respiratory mucous membrane, and on that elaborate system of reflexes which control the rate of internal combustion. Modern civilisation, so far as temperature is concerned, tends to make the human body a hot-house plant.

Metchnikoff perceived that civilisation had plunged man's body into a new environment, and that the rate of its progress had far outstripped the power of adaptive response which had carried man so far beyond the anthropoid stage. A belief grew within him—almost a grudge—that Nature was letting man down. He brought against the evolutionary powers which preside over the destiny of man both sins of omission and sins of commission. We shall deal with a sample of each. The first complaint on his list of omissions is that we have not shed from our skins the last remnants of an anthropoid pelage; hair on the body, he held, was useless and a source of disease. Whether or not a completely hairless body is desirable we may leave as a moot point; a hairless breed of dogs has been produced and no doubt a hairless race of man could be evolved. In this matter the Caucasian has been outstripped by the Negro and by the Mongol, the most hairless of races. It is more to the point to inquire how man has come by a comparatively hairless skin, and in the solution of this problem we have been making some advance. A hairless condition became possible with the evolution of the higher vertebrates; a foetus in the womb draws its heat from the mother's body; it has no need of a hairy covering until the period of birth arrives. There is in the Museum of the Royal College of Surgeons of England a chimpanzee foetus in the eighth month of development; the hair of its head and body has reached a stage identical with that of a newly-born child. A stage of development which is evanescent in the foetal anthropoid has become permanent in us. We have come by a new character through the inheritance of one evolved in foetal life. Many of our structural features have come to us in this way.⁷ The base of the human skull is greatly

flexed. In the foetal stage of all mammals the basicranial axis is bent, but in man only has this character been carried into adult years. Foetal inheritance becomes more and more possible for man because civilisation tends to make man's world into a protective womb.

As an example of a sin of commission, the introduction of a new and useless structure to the human body, Metchnikoff cites the case of the hymen. It is scarcely true to describe, as he does, the hymen as a new structure; it is present at a certain stage in the embryonic life of every higher mammal; it is only in the human species that it persists and forms a definite and substantial structure in the fully formed body. The hymen provides another example of the human body coming by a new character by retaining and modifying a structure which made its first appearance during embryonic or foetal life. When we seek to explain its use we must enter the purview of psychology, for round man's sense of sex has grown up a strange hinterland in his subconscious mind. Metchnikoff described the hymen as "an unpleasant impediment," but love, as the world has long recognised, thrives on impediments. The human prepuce, although not a new structure, was, in Metchnikoff's opinion, a useless and dangerous one; circumcision in one generation does not diminish the completeness of its development in the next. In this the prepuce resembles the hymen. Indeed, Metchnikoff said of the latter structure that the only purpose it had ever served was "the overthrow of the dogma of the inheritance-acquired characters."

The examples which I have cited above of the failure of man's body to adapt itself to present requirements are of little more than academic interest, but when Metchnikoff applied his analytical genius to the problems of man's alimentary system, he carried us into the realms where thought becomes the guide to action. "It would be no longer rash to say," so he wrote in 1903, "that not only the rudimentary appendix and the caecum, but the whole of the human large intestine are superfluous and that their removal would be attended with happy results." Since Metchnikoff penned this sentence, the operation of complete colectomy has been performed on many thousands of men and women, but I do not think that even the surgeons who have performed this operation most frequently and most successfully would maintain that a man or woman who has been rendered colonless enjoys that moderate share of health which falls to the average intact individual. If a finger becomes permanently fixed in an awkward position, the hand is improved by the amputation of the offending digit, but the relief thus gained does not restore the hand to its original capacity. The relief afforded by colectomy is of the same kind; the results of that operation in no wise bear out Metchnikoff's doctrine that the colon has become a superfluous organ in man's body. On the other hand, we have only to consult the pages of the medical press, to listen to tales which reach our ears daily, to note the ever-growing demand for patent purgatives, to be convinced that there is, as Metchnikoff maintained, a grave disharmony between the functional capacities of our great intestine and the dietary which modern civilisation has compelled us to adopt. The way out of our difficulties is not to call the colon a useless organ.

⁶ *Lancet*, 1910, 2, p. 959.
⁷ Prof. Louis Bolk, "The Part played by the Endocrine Glands in the Evolution of Man," *Lancet*, 1921, vol. 2, p. 588. See also Keith, "The Evolution of Human Races in the Light of the Hormone Theory," *Johns Hopkins Hospital Bulletin*, 1922, vol. 33, p. 195.

a "sewage pipe," a "cesspool," but to discover its original purpose and ascertain how far we can modify our mode of living to suit its inherited capacity. What that capacity is we have yet to discover, for we have no complete or exact knowledge of the uses of the great intestine in any animal whatsoever. So far as the human organ is concerned, surgery has stepped far in advance of physiology.⁸

Since Metchnikoff first promulgated his belief that the appendix, cæcum, and colon had become superfluous organs in man's body, our knowledge concerning the evolution of these structures, and of certain conditions which regulate their action, has increased. That increase of knowledge rehabilitates the ancient belief that Nature in her evolutionary mood exercises not only a surprising ingenuity but also the strictest economy. The ferments and catalysts elaborated by plants for their own use were made to serve in the animal body as vitamins. How necessary such substances are for the proper working of the great bowel has been shown by the recent researches of McCarrison⁹ and of Cramer.¹⁰ It was for the purposes of economy that the great bowel came into existence. In fishes, the earliest vertebrate forms known to us in the living state, potent digestive juices have to be produced at the expense of body tissues; with the evolution of land-living, air-breathing forms, much of this expenditure was saved by the utilisation of bacterial digestion. The great bowel was added to the original intestine for this purpose, the oldest part of this annex being the cæcum and appendix. The great bowel as we know it in fishes is a mere diverticulum from the

hinder end of the gut; it takes no part in the digestion of food. Its epithelium forms a glandular structure which has all the appearance of an organ designed for the supply of an internal secretion.¹¹ That secretion, whatever it may prove to be, is carried to the liver by the inferior mesenteric vein.

In the mucous membrane of the human great bowel, there are embedded in a stratum of reticular tissue—of reticulo-endothelium—some 15 millions of minute test-tube glands—the glands of Lieberkühn. No one who has noted the structure and setting of these glands, and the fine changes which their cells undergo in the course of action, can believe that their sole function is to supply a lubricating fluid for the intestine; they have all the appearance of also supplying an internal secretion, and the evolutionary history of the colon favours such an inference.¹² The reticular stratum of the colon, which Dr. Scott Williamson¹³ regards as the most important constituent of its mucous membrane, and in this I agree with him, represents a spleen of considerable size. Indeed, just as the liver and pancreas represent extrusions of highly specialised parts of the intestinal epithelium, the spleen represents a specialisation of the reticulo-endothelium of the alimentary canal; in cyclostomes¹⁴ the spleen is still intra-intestinal. Nor must we forget how greatly the large intestine is linked to the central nervous system—both by afferent and efferent pathways. When we take all these considerations into account, we must conclude that the great bowel of man is not a useless or superfluous organ, but one which we, in our ignorance, are maltreating.

¹¹ Dr. Doris R. Crofts, *Proc. Zool. Soc.*, 1925, Part I., pp. 101, 170.

¹² I have not mentioned the excretory function of the colon. This has been investigated by Dr. Owen T. Williams, see *Brit. Med. Journ.*, 1912, vol. 2, p. 1281.

¹³ *British Journal of Surgery*, 1914, vol. 2, p. 306.

¹⁴ J. Mawas, *C.R. Acad. Sci.*, 1922, vol. 174, pp. 889, 1041.

(To be continued.)

High Frequency Rays of Cosmic Origin.¹

By Dr. R. A. MILLIKAN,

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IT was so early as 1903 that the British physicists, Rutherford and McLennan, noticed that the rate of leakage of an electric charge from an electroscope within an air-tight metal chamber could be reduced by enclosing the chamber within a completely encircling metal shield or box with walls a centimetre or more thick. This meant that the loss of charge of the enclosed electroscope was not due to imperfectly insulating supports but must rather be due to some highly penetrating rays, like the gamma rays of radium, which could pass through metal walls as much as a centimetre thick and ionise the gas inside.

In view of this property of passing through relatively thick metal walls in measurable quantity, the radiation thus brought to light was called the "penetrating radiation" of the atmosphere and was at first quite naturally attributed to radioactive materials in the earth. But in 1910 and 1911 it was found that it did not decrease as rapidly with altitude as it should upon his hypothesis. The first significant report upon this

point was made by a German physicist, Gockel, who took an enclosed electroscope up in a balloon with him to a height of 13,000 feet and reported that he found the "penetrating radiation" about as large at this altitude as at the earth's surface, despite the fact that Prof. Eve, of McGill University, had calculated that it ought to have fallen to half its surface value in going up 250 feet.

In 1912-14 two other German physicists, Hess and Kohlhorster, repeated these balloon-measurements of Gockel's, the latter going to a height of 9 km., or 5.6 miles, and reported that they found this radiation decreasing a trifle for the first two miles and then increasing until it reached a value at 9 km., according to Kohlhorster's measurements, eight times as great as at the surface.

This seemed to indicate that the penetrating rays came from outside the earth, and were therefore of some sort of cosmic origin. The War put a stop to the world over to further studies of this sort, but so soon as we could get the proper instruments built after the War in the newly equipped Norman Bridge Laboratory of Physics, I. S. Bowen and myself went to Kelly Field,

¹ Address delivered before the National Academy of Sciences, Madison, Wis., U.S.A., on November 9.

near San Antonio, Texas, with four little recording electroscopes which we succeeded in the spring of 1922 in sending up in sounding balloons to almost twice the heights which had previously been attained. The highest flight reached the altitude of 15.6 km., or nearly 10 miles.

These instruments were interesting in that, though they were built to hold 300 cubic centimetres of air at 150 pounds pressure, and were provided each with a recording barometer, thermometer, and electroscope, also with three different sets of moving photographic films and the necessary driving mechanism, the total weight of the whole instrument was yet but 180 grams, or about 7 ounces.

In these experiments we expected, if the results previously reported were correct, to find very large rates of discharge; for our instruments went up to such heights that nine-tenths of the atmosphere had been left beneath them, and only one-tenth was left to cut down, by its absorption, the intensity of the hypothetical rays entering from outside. The results were contrary to this expectation. They proved conclusively, however, in agreement with the observations of Hess and Kohlhorster, that the penetrating radiation was greater at great altitudes than at the surface, but that the amount of the increase was not more than a fourth of that predicted from the results of the German observers. (Two years later they reduced their estimates, after further experiments, so that they were no longer in conflict with our measurements.)

VARIATION OF ABSORPTION WITH ALTITUDE.

Since the origin of the rays was still uncertain, with indications in favour of some cosmic source, Dr. Russell Otis and myself felt that the next step was to find out how penetrating the rays were; and since they were weaker at the surface than higher up, we went to the top of Pike's Peak in the summer of 1923, carrying up 300 pounds of lead and a big 6 ft. $\times$ 6 ft. $\times$ 6 ft. water tank for the sake of making absorption measurements on such rays as were found at that altitude.

We found that though our electroscopes discharged twice as fast on Pike's Peak as at the altitude of Pasadena, the rays were cut down so fast by our absorbing screens that it was certain that the greater part of them were not much, if any more, penetrating than the ordinary gamma rays emitted by radium. We found, further, that the rate of discharge of our electroscope was decreased by 10 per cent. by a heavy snowstorm which occurred during the week in which we were on the peak. This showed conclusively that the chief part, at least, of the rays with which we were experimenting on the peak were of local origin, and that they might be due to radioactive matter which in some unknown way got into the upper regions of the atmosphere.

The search for the cause of the increase with altitude in the intensity of these soft gamma-like rays became, therefore, quite as interesting as the question of the existence of a very penetrating radiation of cosmic origin, since this latter would produce at the most but a fraction, and no large fraction either, of the observed increase between Pasadena and Pike's Peak. Mr. Harvey Cameron and I therefore planned experiments for the summer of 1925 which were designed (1) to

settle definitely the question of the existence or non-existence of a small, very penetrating radiation of cosmic origin, and (2) to throw light on the cause of the variation with altitude of the softer radiation of the gamma ray type which we had found more than twice as intense on Pike's Peak as at Pasadena.

HIGH PENETRATING POWER.

To bring to light the very penetrating radiation, if it existed, it was necessary to find at very high altitudes very deep snow-fed lakes, for any radioactive contamination of the water through its seepage through the earth would vitiate the results obtained by sinking electroscopes to different depths beneath the surface of the lake.

We chose for the first experiment Muir Lake (11,800 feet high), a beautiful body of water hundreds of feet deep just under the brow of Mount Whitney, the highest peak in the United States. Here we worked for the last ten days in August, sinking our electroscopes to various depths down to 60 feet. Our experiments brought to light altogether unambiguously a cosmic radiation of such extraordinary penetrating power that the electroscope reading kept decreasing down to a depth of 45 feet below the surface. The atmosphere above the lake was equivalent in absorbing power to 23 feet of water, so that we had found rays, coming into the earth from outer space, so penetrating that they could pass through 45 plus 23 equalling 68 feet of water, or the equivalent of 6 feet of lead, before being completely absorbed. This represents rays much harder (more penetrating) than any which had before even been imagined. The most penetrating X-rays which we produce in our hospitals cannot go through half an inch of lead. Here were rays originating somewhere out in space at least a hundred times more penetrating than these.

Further, high penetrating power means, according to modern physics, simply high frequency or short wave-length. Our experiments indicate, then, that there is a region of frequencies as far up above the X-ray frequencies as are these latter above the frequencies of light waves. They show quite definitely, too, that these highest frequency rays are not homogeneous, but have a measurable spectral distribution, the shortest waves which we observed being a little less than twice the frequency of the longest, for the rays which we actually observed in Muir Lake changed hardness or frequency as they were filtered through greater and greater thicknesses of water, just as X-rays are successively hardened by passing through successive layers of lead. The experiments with the sounding balloons indicate that the frequencies of these cosmic rays do not extend over into the X-ray region of frequencies, else we should have obtained larger discharges in the experiments with sounding balloons when nine-tenths of the atmosphere had been left beneath us.

Further, we obtained good evidence that these cosmic rays shoot through space in all directions, this evidence being found in the fact that we could observe no change whatever in their intensity throughout day or night.

All the results obtained in Muir Lake were checked with wonderful completeness by another set of observa-

tions in another snow-fed lake—Arrowhead Lake—300 miles away from Muir, 7000 feet lower, and equally deep, where the Arrowhead Lake Development Company kindly put all their facilities at our disposal. Indeed, the absorbing power of the atmosphere between the elevations of Muir and Arrowhead Lakes is the equivalent of about two metres of water, and as a matter of fact, every reading in Arrowhead was practically identical with one taken in Muir at a depth two metres lower.

ORIGIN OF HIGH FREQUENCY RAYS.

We can draw some fairly reliable conclusions as to the origin of these very penetrating and very high frequency rays. The most penetrating rays that we have known anything about thus far, the gamma rays of radium and thorium, are produced only by nuclear transformations within atoms. This means that they are produced by the change of one atom over into another atom, or by the creation of a new type of atom. It is scarcely possible, then, to avoid the conclusion that these still more penetrating rays which we have here been studying are produced similarly by nuclear transformations of some sort. But these transformations must be enormously more energetic than are those taking place in any radioactive changes which we know anything about. For the frequency of any emitted ray is, according to our present knowledge, proportional to the energy of the subatomic change which gives birth to it. We can scarcely avoid the conclusion, then, that nuclear changes having an energy value perhaps fifty times as great as the energy changes involved in observed radioactive processes are taking place all through space, and that signals of these changes are being sent to us in these high frequency rays.

The energy of the nuclear change which corresponds to the formation of helium out of hydrogen is known, and from it we have computed the corresponding frequency and found it to correspond closely to the highest frequency rays which we have observed this summer. The computed frequencies of these rays also correspond closely to the energy involved in the simple capture of an electron by a positive nucleus. It is possible that this phenomenon is actually going on all through space. This is, I think, the most probable source of these rays. It is true that the formula underlying this computation of the frequencies of these rays from their absorption coefficient is of uncertain validity. It is a formula, nevertheless, that works well in the frequency range in which we can get independent checks upon it, namely, in that of the X-ray field and the gamma ray field.

According to this formula, the wave-length of the shortest waves which we have here investigated is 0.0004 Ångströms, or but one-fiftieth of that of the hardest gamma rays heretofore known, and but one-tenth millionth that of ordinary light. The longest wave-length which we have found is about five-thirds of the shortest, or 0.00067 Ångströms.

When these extraordinarily high frequency rays strike the earth, according to the now well-established Compton effect, they should be transformed partially into soft scattered rays of just about the hardness, or the wave-length, of the soft rays which we have

actually observed on Pike's Peak and Mount Whitney. The reason these soft rays were more plentiful on the mountain peaks than at Pasadena would then be found simply in the fact that there are more than twice as many of the hard rays to be transformed at the altitudes of the peaks than at that of Pasadena. This seems to be the solution of the second of our summer's problems.

But how can nuclear transformation, such, for example, as the formation of helium out of hydrogen or the capture of an electron by a positive nucleus, be going on all through space, the resulting rays coming apparently as much from one direction as from any other, and certainly not a whit more plentifully from the direction of the sun than from that diametrically opposite to it, as evidenced by the entire equality of our midday and midnight observations? The difficulty is not so insuperable, in view of the transparency even of large amounts of matter for these hard rays, combined with Hubble's recent proof at the Mount Wilson Observatory that some of the spiral nebulae are at least a million light years away. The centres at which these nuclear changes are taking place would then only have to occur at extraordinarily widely scattered intervals to produce the intensity of the radiation observed at Muir Lake.

The only alternative hypothesis to that above presented, of high frequency rays traversing space in all directions, might seem to be to assume that the observed rays are generated in the upper layers of the atmosphere by electrons shooting through space in all directions with practically the speed of light. This hypothesis might help in interpreting the mysterious fact of the maintenance of the earth's negative charge, but it meets with insuperable obstacles, I think, in explaining quantitatively the variation with altitude of the ionisation in closed vessels. In any case, this hypothesis is, in its most important aspect, very much like the one represented above, for it, too, fills space with rays of one sort or another travelling in all directions with the speed of light. From some such conception as this there now seems to be no escape. Yet it is a conception which is almost too powerful a stimulus to the imagination. Prof. MacMillan, of Chicago, will wish to see in it evidence for the condensation into matter, out somewhere in space, of the light and heat continually being radiated into space by the sun and stars, and the psychists will be explaining all kinds of telepathic phenomena by it.

In any event, our experiments seem to point to the following conclusions:

- (1) That these extraordinarily penetrating rays exist;
- (2) That their mass absorption coefficient may be so high as 0.18 per metre of water;
- (3) That they are not homogeneous, but are distributed through a spectral region far up above X-ray frequencies—probably 1000 times the mean frequencies of X-rays;
- (4) That these hard rays stimulate, upon striking matter, softer rays of about the frequency predicted by the theory of the Compton effect;
- (5) That these rays come into the earth with equal intensity day and night and at all hours of the day or night, and with practically the same intensity in all directions.

Current Topics and Events.

SOME progress is being made with the unifying of the electric supply undertakings in Great Britain, and electricians are beginning to look forward to larger generating stations and higher electric pressures of distribution. This is reflected by the activity of research in connexion with the dielectrics of cables for use with very high pressures. Both the Institution of Electrical Engineers and the Junior Institution of Engineers have discussed papers on this subject this year. In both these papers the progressive nature of a breakdown when it occurs is emphasised. There seems, however, to be some confusion as to what physicists mean by the electric strength of a homogeneous dielectric. This electric strength varies with temperature and mechanical pressure. The so-called "time lag" before the insulating material breaks down is due to the fact that its temperature is gradually rising and its electric strength is therefore diminishing. A spark or a brush discharge occurs when the electric strength becomes less than the maximum applied electric stress. To attempt to express "time lag" by a formula seems to us to be waste of time. There are many miles of 33,000-volt cable in use in Great Britain and some of them have been in uninterrupted operation for more than six years. Mr. Emanuelli of the Pirelli Cable Company said that a cable had been in successful operation in Italy for eighteen months at 130,000 volts. He attributed its successful operation to the fact that air and gas bubbles had been entirely eliminated from the insulation. The manufacture of cables which will withstand these enormous pressures is a very considerable step in advance, and, provided that the price is reasonable, it will affect very appreciably the trend of the development of electrical supply all over the world. The cost of the transmission cables in any large scheme of electricity supply is always the major part of the capital cost. As raising the pressure largely reduces this cost, it will cheapen the supply to the public.

THE problems of transport in tropical Africa, especially in relation to cotton-growing, are discussed in a memorandum prepared by the Mechanical Transport Sub-Committee of the Empire Cotton-growing Corporation. After a general survey of means of transport, it is pointed out that transport facilities are unlikely to develop along the same lines as in Great Britain. A network of branch railways or of modern macadamised roads is out of the question in the great spaces of thinly inhabited and sparsely cultivated Africa. Even if the volume of traffic warranted the construction of good roads, their upkeep would be prohibitive in regions of torrential rain. In the belief that for many years to come the roads in Africa will be unmetalled, the chief problem is to find what type of vehicle will inflict the least damage on the roads. With this end in view it is essential to maintain a low pressure per square inch of the road surface. After discussing the number, width, and diameter of wheels, the sub-committee

considers that the caterpillar or track system is a preferable alternative to the use of wheels. The most promising development of this device is the "half-track" system in which the front wheels are retained for steering purposes and the rear wheels are replaced by a flexible double track system. Trials with certain vehicles constructed on this principle hold out hope that the solution of the transport problem lies in that direction, although many improvements in the vehicles are still required.

IN order to commemorate the great services made to polar exploration by the late Dr. W. S. Bruce, leader of the Scottish National Antarctic Expedition, a fund has been raised by subscription, the proceeds of which will be awarded biennially "for some notable contribution to Natural Science, such as to zoology, botany, geology, meteorology, oceanography and geography, the contribution to be in the nature of new knowledge, the outcome of a personal visit to the polar regions on the part of the recipient." The award will consist of a medal, inscribed "Exploration of Polar Regions" and on the reverse "For Valuable Services," modelled on that designed by Dr. Bruce to commemorate the return of the *Scotia*, with in addition a sum of money. In the making of the award, preference will be given, other things being equal, to an explorer of Scottish birth or origin, and to one at the outset of his career as an investigator. The Royal Society of Edinburgh has been asked by the subscribers to accept and has accepted custody of the Bruce Memorial Fund, and awards will be made by a joint committee representing that society, the Royal Physical Society and the Royal Scottish Geographical Society. The first award will be made in 1926. For the purpose of increasing the money award of the prize, subscriptions may still be sent either to Mr. A. N. G. Aitken, S.S.C., 37 Queen Street, Edinburgh, or to the Treasurer of the Royal Society of Edinburgh.

IN a paper on the future of engineering, by Dr. W. B. Parsons, which appears in the August number of the *Journal of the Franklin Institute*, stress is laid on the fact that engineering as we now know it is little more than a century old. The main characteristics of the present epoch are the substitution of mechanical for animal power and the application of mechanical power to secure results obtainable in no other way. If the use of mechanical energy were abolished our much-vaunted civilisation could scarcely recover from the shock. The energy that we use and on which our civilisation mainly rests comes from the burning of coal and oil. From 1800 to 1860 the consumption increased ten times, from 1860 to 1920 it again increased ten times. More than a ninth of the total consumption of fuel is now due to oil. If we assume that the consumption doubles every 16 years, then in a little more than 200 years our total reserves will be exhausted. It is certain, therefore, that the rate of consumption of fuel cannot go on

increasing at the present rate and that the cost will go on increasing. Using excellent steam engines, only about 20 per cent. of the energy of combustion is converted into useful work and very little increase is possible with steam. To utilise our water power resources fully, we need some economical method of storing energy. This is one of the pressing problems of hydro-electric engineering. It is estimated that more than one-third of the potential horse-power of the world is to be found in Africa. When energy can be stored and transported or transmitted, the great sources of water power existing in the tropics would become available. But the total water power in the world falls far short of its needs. Atomic energy, the heat of the earth, tides and waves at present offer very little hope. Doubtless, as the need becomes more pressing, wind-mills, especially in those places where the trade winds flow fairly steadily, will be largely utilised. Solar heat appears, however, to be the most promising source. There is an urgent call to engineers with the aid of physics and chemistry to invent a more efficient power-producing engine than the steam generator, and a device to store energy that can be much more readily utilised than the electric accumulator.

"THE first epistle of Henry the Chemist to the Uesaniens" is the somewhat bizarre title of a characteristic article by Prof. H. E. Armstrong printed in the September issue of the *American Journal of Chemical Education*. Beginning with a very long epigraph, after the manner of a Pauline epistle, the author proceeds to express his opinions on topics connected with the ethics of belief, education, literature, chemistry, and culture. His incisive style reminds one of Shaw and Chesterton, who by wealth of hyperbole and paradox, lame aphorisms, and parodied proverbs, know well how to arrest attention, and also of the late Lord Morley, who, when asked for his opinion on the prose of Carlyle, replied that he preferred the English language. Prof. Armstrong denounces the modern Press, present-day teaching of science, the poor literary value of scientific writing, and the absence of cultural value in the science of to-day; but he reserves the vials of his wrath for the adherents of the hypothesis of ionic dissociation, who above all others appear to him to sin most against the Pauline injunction of "proving all things, and holding fast that which is good," the freedom to do which, he says, is the only intellectual freedom worth having. Through this excursive "epistle" runs a serious *leitmotif* that will appeal to all, namely, that dogmatism in science is the negation of science, a truth which is of wider applicability than is sometimes assumed.

A LONG-FORGOTTEN hoax and a controversy almost equally overwhelmed by oblivion is recalled by Dr. L. A. Gausman in an article, "The Figured Stones of Würzburg," which appears in the *Scientific Monthly*, vol. 21, No. 5. In the early years of the eighteenth century, when the origin and significance of fossils was being hotly debated, Dr. Johann Bartolomaeus Adam Beringer, doctor of medicine and philosophy

and professor of natural philosophy in the University of Würzburg, publicly committed himself to the belief that fossils were merely the capricious fabrications of God, who had committed them to the earth for some inscrutable purpose. Thereupon students and others made a number of fantastic "fossils" of clay, which they buried on a hill near Würzburg. They were discovered by Prof. Beringer and accepted as genuine and as supporting his views. The ground was then further "saled" with still more fantastic forms, inscribed in Hebrew, Babylonian, Syrian, and Arabic. In 1726, Prof. Beringer, notwithstanding the remonstrances of his friends, published his "results" in a quarto "Lithographia Würzburgensis," in which his methods of investigation and safeguards against error and fraud were fully described. The book was received with universal ridicule, and the author died shortly after, a broken man.

THOSE who regret the fact that a site of such importance in the history of palaeontological and archaeological studies in Great Britain as Kent's Cavern should not have been acquired by some public body to ensure its safe-keeping, will read with mixed feelings a sketch of the life and labours of the Rev. John MacEnery (1796-1841) by the Rev. Kevin Clark, of which instalments appear in the October and November issues of *Blackfriars*. MacEnery was private chaplain to the Carey family of Tor Abbey while carrying on his exploration of the cavern, and had no other financial resources. Consequently his valuable notes remained unpublished at the time of his death, and apparently disappeared when his collections were dispersed by auction. The manuscript describing his explorations was printed by the Devonshire Association in 1859; but his notes, which were to be worked up into the promised "Cavern Researches," but never appeared, would probably raise still further the reputation of the man whose opinions on the age of the stone implements found beneath the stalagmite have been vindicated by time as against those of his distinguished correspondents, Buckland and Cuvier.

IN the issue of *NATURE* of September 12, p. 396, Dr. A. Gaschler referred to experiments he had made, in which he had obtained by artificial means an increase of 1.4 to 20 times the normal yield of uranium X from the disintegration of uranium. In view of the significance of such a result, were it to be substantiated, the following remarks of O. Hahn and L. Meitner, which appeared in the issue of *Die Naturwissenschaften* for October 30, are of interest: "Dr. Gaschler has undertaken experiments at low potentials and with heavy currents in our laboratory and under our control. According to his previous communications he had, with this experimental arrangement, obtained a manifold increase in the activity of his uranium preparations. These experiments, according to our measurements, yielded absolutely negative results, and some failed in the preliminary stages. The experiments with high-tension currents were carried out elsewhere. The uranium preparation from such an experiment, undertaken in a

laboratory of the General Electric Company in Berlin, was handed over to us for examination by a gentleman interested in the phenomenon. Our measurements failed to reveal any detectable increase in the quantity of UX, although we should have been able readily to detect even an increase of only 1.4 times the normal amount. Owing to the importance of the problems involved, we feel it our duty to make this statement."

THE Report of the Meteorological Committee to the Air Council for the year ended March 31, 1925, has just been issued by H.M. Stationery Office (price 1s. 9d. net). This is the seventieth year of the Meteorological Office and the fifth year in which the cost of the Office has been borne on Air Ministry votes. A special feature of interest in the report is the establishment of a division to deal with questions concerning meteorology for airships, which has been rendered necessary by the decision of His Majesty's Government to proceed with the development of airships and ultimately to establish a regular airship service between Great Britain and India, and the formation of a permanent committee on agricultural meteorology in connexion with the Ministry of Agriculture. A general weather forecast covering all districts of the British Isles has been regularly sent to the British Broadcasting Company in place of the separate district forecasts previously supplied, and notifications when possible are issued of spells of settled weather. An important feature to improve weather forecasting during the year was the establishment by the Royal Air Force of a Meteorological Flight to obtain regular observations of upper air temperature by means of aeroplane flights. Gale warnings have proved very satisfactory. The study of atmospheric pollution has been continued, and an investigation into the effect of suspended impurity upon the incidence of bronchial diseases has been arranged in collaboration with the Ministry of Health. Marine meteorology continues to make good headway, and the many varied undertakings of the Meteorological Office show an increasing activity and general interest in the development of meteorology.

A BRIEF account of the visit of foreign men of science to Russia on the occasion of the celebration of the bicentenary of the Academy of Sciences, which appears in Bull. No. 14 of the U.S.S.R. Society of Cultural Relations with Foreign Countries, is supplemented by a survey of the various scientific and artistic activities which have been initiated or are being supported by the Soviets. Oriental studies have always formed an important part of the Academy's activities. Of these the most valuable was perhaps the "Buddhist Library" of 60 volumes, while the Tibetan collections were the richest in the world. These studies are now being continued by the publication of Pekarsky's Yakut dictionary, and important researches in Moslem culture are being carried on, the numismatic researches of Frein being specially noted. An expedition to investigate the condition of the workers in the Ural Mountains in the eighteenth and nineteenth centuries has already discovered a number of documents of importance for economic and social

studies and collected headgear of the nineteenth century, implements used in punishing the workers, cut glass and pictures painted by serfs. A botanical expedition has left for Persia, and will study an unexplored region on the outskirts of Nishpur. Songs of various Caucasian peoples are being studied and edited with a special view to their relation to ancient eastern cultures. A large number of objects belonging to the thirteenth and fourteenth centuries has been found in the course of excavations of tombs, Moslem chapels, and other buildings in the Crimea by Prof. Borogdin. These discoveries throw much light on the culture of the ancient Tartars. An account of the excavations is to be published shortly.

THROUGH the interest of Prof. William Trelease, of Illinois, U.S.A., who had personal relations with three generations of the distinguished botanists commemorated, the City of Geneva has marked their one-time residence at 3 Cour de St. Pierre with a tablet bearing the following inscription: "Ici ont vécu et travaillé pendant un siècle les botanistes genevois Augustin-Pyramus de Candolle, 1778-1841, Alphonse de Candolle, 1806-1893, Casimir de Candolle, 1836-1918; Augustin de Candolle, 1868-1920."

It is announced in *Science* that Dr. J. B. Whitehead, professor of electrical engineering and dean of the faculty of engineering of the Johns Hopkins University, Baltimore, has been awarded the triennial prize, for the year 1925, of the Fondation George Montefiore of Liège, Belgium, for the best original work contributing to scientific advancement in the technical applications of electricity. The prize is awarded for his series of papers entitled "Gaseous Ionisation in Built-up Insulation." The amount of the prize this year is 4000 francs. This is the second time that Dr. Whitehead has been awarded this prize.

THE Council of the Iron and Steel Institute makes annually a limited number of grants from the research fund founded by the late Mr. Andrew Carnegie in aid of metallurgical research work. The object of the scheme is to enable students, who have passed through a college curriculum or have been trained in industrial establishments, to conduct researches on problems of practical and scientific importance relating to the metallurgy of iron and steel and allied subjects. Candidates, who must be under thirty-five years of age, must apply before the end of next February on a special form to be obtained from the Secretary of the Institute, 28 Victoria Street, London, S.W.1. The value of the grant will not exceed £100 in any one year.

WE learn from *Science* of October 30 that an expedition to Greenland is being organised by Prof. W. M. Hobbs. The main object of the expedition, which will leave the United States in July next year, will be the establishment of a meteorological observatory on the inland ice at an altitude of 6000 to 7000 feet some hundred and fifty miles from the west coast. A staff will be maintained there for a year, and the data will be transmitted daily by wireless to the United States and Europe. Prof. Hobbs believes that this service will be of great value in

forecasting The expedition will co-operate with Dr L. Koch, who is to lead a Danish scientific party to Scoresby Sound on the east coast, and to cross the interior to Holstenborg on the west coast. This journey is expected to occupy about two months. A further object of Prof. Hobbs's inland station will be the investigation of the upper atmosphere by means of rubber balloons. It is also proposed to take two aeroplanes for reconnaissance work over the ice cap in various directions.

A BIBLIOGRAPHY of meteorological literature, No. 8, prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office, has recently been issued by the Royal Meteorological Society (price 2s. 6d. to non-fellows). The bibliography was incorporated in the Meteorological Society's Journal from 1917 until 1920, but has since been issued as a separate publication in six-monthly parts. The publication is of considerable value to students of meteorology in all parts of the world.

THE British Museum (Natural History) has recently issued an illustrated brochure entitled "British Mosquitoes and their Control," which is obtainable

at the Museum or through booksellers for the low price of 6d. This pamphlet forms No. 4 of the Economic Series and is written by Mr. F. W. Edwards and Col. S. P. James, who are recognised authorities on their subject. Practically all the information commonly sought for by medical officers and the general public will be found readily available, in its pages. The distribution and habits of the twenty-six species of British mosquitoes are briefly, but clearly, described, and there is a useful account of remedial and control measures.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Assistant at the Low Temperature Research Station, Cambridge—Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (December 14). Chair of philosophy—Registrar, University, Bristol (February 1). Lectureships in botany and in domestic science—Secretary, Huguenot University College, Wellington, C.P., South Africa. Biochemist—British Association of Research for the Cocoa, Chocolate, Sugar, Confectionery and Jam Trades, 2 Dalmeny Avenue, N.7.

Our Astronomical Column.

THE NEW COMETS.—These have both been well observed. The orbit of Comet van Biesbroeck presented great difficulties owing to the apparent motion being slow and almost directly from the sun. The following orbit by J. Møller and B. Strömberg is the best available, but it is still very uncertain:

T	1925 Sept. 29 370 U.T.
ω	99° 10' 73"
Ω	334 46 45
i	46 57 15
log q	0.16043

EPHEMERIS FOR 0^h.

	R.A.	N. Decl.	log r .	log Δ
Dec. 2.	12 ^h 5 5 ^m	30° 13'	0.2310	0.1842
10.	12 7 1	27 55	0.2460	0.1751
18.	12 6 3	25 48	0.2929	0.1647

The brightness is slowly declining.

The following orbit of Comet Wilk-Peltier is from rather rough observations, but is fairly near the truth.

T	1925 Dec. 6.936 U.T.
ω	117° 56'
Ω	131 47
i	144 59
log q	9.88422

EPHEMERIS FOR 0^h.

	R.A.	Decl.	log r .	log Δ .
Dec. 4.	19 ^h 19.6 ^m	4° 38' N.	9.885	9.961
8.	19 33.4	0 2 S.	9.884	0.018
12.	19 43.4	3 47 S.	9.888	0.068
16.	19 51.0	6 53 S.	9.896	0.113

THE ORIGIN OF THE STARS.—A letter by Dr. J. H. Jeans in the *Observatory* (November) is of interest as tracing the modifications of his views that have taken place as new determinations have been made of the distances of the spiral nebulae. In a paper in *Phil. Trans. Roy. Soc.* for 1902 he showed that condensations forming stars might be expected to appear in

gaseous masses of density 10^{-23} , their distance apart being 10 parsecs. In 1917 he concluded that this process might be going on in the spiral nebulae, the visible condensations being taken as the nuclei of stars. The distances were at first assumed from Van Maanen's measures, but the recent discovery of Cepheids in the spirals indicates a much greater distance for them, and the masses of the condensations are increased from 3 sun to 16 sun. The only revision of his earlier work that he finds necessary is to conjecture that the radiation of the nebula as a whole is governed by different laws from that of the stars formed from it. The new-born stars are not necessarily giants: if the density of the nebula is as high as 10^{-10} , they will be dwarfs. It is conjectured that the group of nebulae near the galactic pole R.A. 12^h 37^m, N. Decl. 14°, may be of this character.

A MASSIVE SPECTROSCOPIC BINARY.—Orbits of many spectroscopic binaries are appearing regularly in the Publications of the Victoria Observatory. Vol. 3, No. 6 deals with an interesting star, No. 216014 in the Henry Draper Catalogue: its R.A. is 22^h 44.2^m, N. Decl. 64° 32', magnitude 6.8: spectrum Bo. The period is 2.3 days, and the minimum masses are 14.23 and 12.37 in terms of the sun, the probable values being half as great again, placing the system among the six most massive ones. The absolute magnitude is given as -2.67, implying a distance of 3400 light-years. The radial velocity of the system is -23.10 km./sec. The H and K calcium lines are sharp, and give a constant radial velocity of -26.28 km./sec. The component of the solar velocity is only -11.40 km./sec., so that the calcium cloud is not stationary with respect to the stellar system, as in some cases. It is conjectured to belong to the binary system, but to be 40 or 50 astronomical units from the stars, at which distance it would not show an oscillation. The diameters of the stars are estimated as 5.4 times that of the sun, giving a density of 0.08 sun. The relative orbital velocity is nearly 500 km./sec.

Research Items.

THE INTERPRETATION OF PREHISTORIC "FINDS."

—An interesting example of the light which can be thrown upon prehistoric objects of doubtful use by ethnographic data is given by Dr. Paul Rivet in the *Compte rendu* of the Liège meeting (1924) of the French Association for the Advancement of Science. Count Bégouen found in the cave at Montesquieu-Avantès (Ariège) an object of stone of which the surfaces were pitted with holes, most of them pierced right through from side to side. The date was either Magdalenian or Neolithic, it was uncertain which. A second object similar in certain respects—the figure of a feline—was found in a Magdalenian stratum in the grotto of Isturitz (Basse Pyrénées). It is, like the object previously described, pierced with holes, five in number, and in addition it is engraved. Four of the engravings appear to represent stylised barbed harpoons. Dr. Rivet suggests a common purpose for these dissimilar objects. He compares them with certain objects of ivory in use among modern Eskimo and described by Culin in his study of the games of American Indians. These are used for a species of cup and ball game, not, however, purely for amusement. Eskimo children use these objects when the sun first reappears after the long winter, to hasten his complete return. The game is definitely magical. In the same way the piercing of the hole by a point of bone in the prehistoric specimens may have been a magical ceremony symbolic of the piercing of game and practised before a hunting expedition.

PLACE-NAMES OF THE VIRGIN ISLANDS.—Since the acquisition in 1917 of the Danish Virgin Islands by the United States, the Coast and Geodetic Survey has been active in the preparation of a modern map and in amplifying the survey of the coastal waters. Although the earliest map of St. Croix was so old as 1671, there was no modern map of the islands incorporating accurate surveys. The latest effort of the Coast and Geodetic Survey is a Geographic Dictionary of the Virgin Islands of the United States by J. W. McGuire (Special Publication No. 103). In this gazetteer all place-names are entered with a note of their situation and derivation, and an indication of those which are rejected as being misspelt, superfluous or obsolete. From the length of the list of works consulted, it is clear that no trouble has been spared in compiling a trustworthy and scholarly guide to the place-names of these islands. The pamphlet also contains an introductory geographical chapter.

THE CYTOLOGY OF CANCER.—The September issue of the *Journal of the Royal Microscopical Society* opens with an admirable account of the general and experimental cytology of cancer by Dr. R. J. Ludford. In order to traverse the wide field more rapidly, Dr. Ludford has summarised the observations and theories in the form of twenty-one diagrams, either original or based on published figures. He gives a brief account of the behaviour of the nucleus and of the cytoplasmic organs—mitochondria, the Golgi apparatus, and the much discussed Plimmer's or bird's-eye bodies—and of keratinisation, and the formation of fat and pigment, and appends a summary of the properties of cancer cells cultivated *in vitro*. In his conclusion Dr. Ludford points out that with present microscopic technique there is no means of distinguishing between a normal and a cancerous cell. The virus of cancer, cultivated by Gye and photographed by Barnard, is smaller than the largest colloidal particles in the cell, and too small to be seen with the microscopes in common use.

THE CONTINUITY OF THE VERTEBRATE NERVOUS SYSTEM.—Frances M. Ballantyne (*Trans. R. Soc. Edin.*, vol. 53, pp. 663-670) records observations on the development of sensory nerves in *Lepidosiren*, and states that the olfactory nerve, the auditory nerve, and the spinal sensory nerves are at first protoplasmic bridges—each being a continuous strand and not a chain of discrete cells—which become fibrillated and lengthen as the embryo forms. Careful observation of large motor neurones in the spinal cord has convinced the author that the terminals of the axons, instead of ending in a club on the surface of the next neurone, really penetrate into its substance, and their neurofibrillæ pass directly and without a break through the cell and along its axon. No sign of a network either in or around the cell could be observed, and the neurofibrils are straight and unbranched within the cell. The dendrites of the neurone are at first thick processes which branch repeatedly and end in tapering threads of cytoplasm which appear to be without neurofibrillæ. The axon branches penetrate either into the body of the cell or into the thick proximal part of the dendrites, and the author supports the view that the great development of the dendrites, with their many branches, is to increase the surface of the cell in order to facilitate the metabolic processes, that is, the function of the dendrites is nutritive rather than nervous.

LEAF-MINING DIPTERA.—Memoir 78 (August 1924) of the Cornell University Agricultural Experiment Station deals with the leaf-mining Diptera of North America. Its author, Mr. S. W. Frost, brings together a good deal of useful information which will appeal to the dipterist and to the economic entomologist. The leaf-mining habit is regarded as having developed from the scavenger habit. Larvæ, having first entered the plant as scavengers, became adapted to an existence within the living host, and finally migrated to the stems and leaves, where they are now miners. It appears that 287 genera, including 589 species of North American plants, are affected by leaf-mining Diptera. The fly *Agromyza curvipalpis* var. *texana* Mall., for example, mines 15 species of Compositæ, and *Cerodontha femoralis* Meig. mines 22 species of Gramineæ. On the other hand, *Agromyza pusilla* Meig. has been recorded from 17 different families of plants, while at the opposite extreme there are other Diptera only known from a single species of plant host. Altogether there are 11 genera, including 61 species of Diptera, recorded as having the leaf-mining habit in North America, and they pertain to six families only. These families are the Cecidomyiidae, Trypanidae, Agromyzidae, Drosophilidae, Ephydriidae, and Anthomyiidae. Biological and descriptive accounts of these various species occupy pp. 29-132, and there follow lists of the leaf-mining Diptera of the world classified both under plant names and insect names. These two catalogues are useful compilations and appear remarkably complete. At the end of the memoir there is a very full bibliography of the subject.

SUGGESTED ALTERNATION OF GENERATIONS IN THE RED ALGÆ.—Prof. R. W. Phillips has certainly resuscitated from the literature a very interesting problem connected with the alternation of generations in the genera *Phyllophora*, *Gymnogongrus*, and *Ahnfeldtia* (*New Phytologist*, vol. 24, pp. 241-255, 1925). Whilst a few species seem to show normal alternation of sexual and tetrasporic generation, in others the tetrasporic generation has not been recorded. But

in these others curious warts have been recorded, which prove to be of the nature of nemathecias, that is, fructifications consisting of threads in which the successive cells of the threads become converted into tetraspores. Schmitz thoroughly investigated these more than thirty years ago and convinced himself and his fellow-investigators that these fructifications were of parasitic nature, and not the tetraspores of the host. In that case, where is the tetrasporic generation of the host plant? Prof. Phillips recalls the curious habit these marine algae have of being parasitic on a nearly allied plant, and asks the pertinent question whether this is not a more striking example still of this with the parasite actually the tetrasporic generation of the same plant.

PRESERVATION OF PLANT TISSUES IN MUD.—Any hint as to the condition under which plant structures may be preserved in soil long enough to permit of their subsequent petrification may ultimately prove of value in the interpretation of fossil structure. It is well, therefore, to have placed on record such observations as those of R. E. Hunter and Winifred E. Mottram (*New Phytologist*, vol. 24, pp. 193-206, 1925), who noted that the moving shingle bank at Blakeney had left exposed some of the old marsh mud containing plant remains which, to judge from the rate of shingle movement, etc., were upwards of 200 years old. The authors have thus been led to undertake the troublesome task of trenching in the salt-pan of the marsh, after drainage. The results show that the roots of the living plants penetrate to considerable depths, and that, in certain circumstances, a plant such as *Triglochin* may decay at the base very slowly whilst the living crown continues active for a very long time. They concluded from the rate of accretion of the marsh that a plant of *Triglochin* examined was perhaps thirty-six years old. The plants exposed by movement of shingle were stems of *Statice Limonium*, and were *in situ*. Investigation of the actual marsh does not appear to have cleared up adequately their presence here, but it has shown that the conditions existing in certain types of "soft" salt-marsh pan certainly favour the preservation of plant remains.

BURMESE PERISSODACTYLA.—Dr. Pilgrim has published in a memoir of the Geological Survey of India (vol. 8, No. 3, 1925) an account of the Eocene Perissodactyla of Burma. These are represented by members of the Titanotheriidae, of the Amynodontidae, an aberrant family of rhinoceroses, and of the Tapiridae. The discovery of titanotheres in Burma is of great interest. The family is typically American, and the only other parts of the world in which it has so far been found are Transylvania, with the sole genus *Brachydiastematherium*, and the newly discovered forms obtained in Mongolia by the American Museum of Natural History expedition. Dr. Pilgrim describes a new genus, *Sivatitanops*, and also a form ascribed to the American genus *Eotitanotherium*. The memoir is well illustrated, but on the technical side the types used by the Publication Department of the Government of India need renewing and the type-setting a stricter supervision.

EARTHQUAKES IN NEW ZEALAND.—The report of the Dominion Observatory, New Zealand, 1924-25 (Bulletin No. 58), contains some notes on the earthquakes of 1924. The Milne seismograph was in operation throughout the year, and the Milne-Shaw seismograph from February 8. During the last ten months of the year, 62 earthquakes were recorded by the former, and 73 by the latter, instrument. Seventy earthquakes were felt during the year, sixty

in the North Island and ten in the South Island, none of which attained a destructive intensity. Maps have been prepared and will shortly be published showing in considerable detail the distribution and intensity of the earthquakes felt in New Zealand.

OBSERVATION OF EARTHQUAKES IN A RAILWAY TUNNEL.—It is well known that earthquakes are either not felt at all or felt only slightly in railway tunnels and mines, even when the shocks at the surface are very strong. In the great Japanese earthquake of September 1, 1923, the damage to tunnels was very slight, and occurred only a few yards from either end. To determine the rate at which the amplitude decreases with increase of depth, Mr. S. Nakamura (*Proc. Phys.-Math. Soc. of Japan*, vol. 7, 1925, pp. 127-130) placed two of Omori's tromometers, one in a transverse shaft connecting two parallel tunnels each $1\frac{1}{2}$ miles long at a depth of 375 feet below the surface and nearly 500 yards from the northern end, the other just outside the tunnel at that end. Comparisons were made for nine earthquakes during the first three months of the present year, and they show that, as a rule, the amplitude of the principal vibrations was less in the tunnel than outside, the ratio ranging from 0.19 to 1.93. Though the general variation in the ratios of the amplitudes with varying periods agrees approximately with that computed from the formula for the Rayleigh waves, the agreement is not close enough to allow the inference that the observed waves were the Rayleigh waves.

PRECIPITATION IN SCANDINAVIA.—A new rainfall map of Norway and Sweden, on a scale of 1 : 2,500,000, is published by H. W. son Ahlmann in *Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt*, Band 3, No. 4, Stockholm. The Swedish part is taken from the map by A. Waltén which previously appeared in the same publication. The Norwegian part is based on the rainfall statistics of the Norwegian Meteorological Institute and the volume of water in the Norwegian rivers. The author has devised also a method of finding the relation between the amount of precipitation and the extent of glaciation in any region. Values of rainfall based on the flow of rivers are adjusted by the addition of certain coefficients of evaporation. The coefficient decreases with the amount of fall, since great falls are at high elevations when temperature is low and evaporation not active. The only region where data were insufficient was Finmark, where rainfall stations are few and there is little present glaciation and no measurement of the flow of rivers. The map shows in a striking way the great variations in rainfall in Norway and the rapid decrease in amount from the west to the east of the Scandinavian peninsula.

UPPER AIR IN SAMOA.—A tentative discussion of pilot balloon flights has been made for the twenty months, May 1923-December 1924, at Apia, Western Samoa, in latitude $13^{\circ} 48' S$, longitude $171^{\circ} 47' W$., by Mr. Andrew Thomson, Director of the Apia Observatory, to obtain the direction and velocity of the trade winds at various altitudes, the nature of the antitrades overlying them, and the variation of these great air movements with the season of the year. Further observations are in progress, but it is not believed that up to a height of 12 km. (7.5 miles) the figures now given will be materially altered. The coasts of South America lie 6200 miles to the eastward, and the continent of Australia 2500 miles to the west, and the expanse of the ocean is otherwise free from the influence of land except for numerous islands, the influence of which is said to be inconsiderable. Apia

lies slightly to the south of the centre of the South-east Trades. On the open ocean in the immediate vicinity of Samoa, winds from the quadrant south-east to north-east blow for 48 per cent. of the time during the months of December and January, and 85 per cent. during June to August. The velocities of the balloons for the two periods May to October (the dry season) and November to April (the wet season) are resolved for each 0.5 kilometre of altitude into north-south and east-west components. The north-south component is weak and approximately the same for wet and dry seasons. The east-west components show that the trade-wind movement of the air to the west decreases steadily with altitude and becomes zero at 3 km. (1.9 miles) in November to February and at 7.2 km. (4.5 miles) in May to August. The eastward motion of the Antitrades setting in at these levels continues to a height of 12 km. (7.5 miles).

DIELECTRIC CONSTANTS OF UNSATURATED COMPOUNDS.—In the *Journal of the American Chemical Society* for October 1925, C. P. Smyth and C. T. Zahn give the results of measurements of the dielectric constants of ethane, ethylene, acetylene and *n*-butylene carried out in order to investigate the structure of unsaturated bonds. Other experiments have indicated that a double bond in a hydrocarbon chain often gives rise to a moment in the molecule which can be determined from the dielectric constant of the substance. The moments of the ethane, ethylene, acetylene and acetylene molecules are zero, but *n*-butylene has a small moment. This evidence shows that the electrons of an unsaturated bond are symmetrically arranged, but have a stronger field of force than a saturated bond. If the unsaturated bond is not symmetrically placed in the molecule, the effect will be to give the substance a measurable moment.

DIMENSIONS OF MOLECULES.—By means of the Stephan-Maxwell-Jeans equation, calculations of the average cross-sectional areas for the molecules of substances can be made from their diffusion coefficients. The rate at which molecules diffuse through a gas depends not only on the absolute velocities of the molecules, but also on their size, since the possibility of collision increases with increasing size or cross-sectional area. In the *Journal of the American Chemical Society* for October 1925, E. Mack, Jr., describes a method of finding diffusion coefficients by direct weighing and gives values for several substances. The average cross-sectional areas of these were calculated from scale models in beeswax by shadow projection, and were in excellent agreement with the values found by the diffusion method, showing that the models of the molecules were of the correct shape. The experiments confirm the view that benzidene and diphenyl have a collapsed structure.

COMPUTATION OF SPECTRAL ENERGY.—The Department of Commerce of the Bureau of Standards has recently published a series of "Tables and Graphs for facilitating the Computation of Spectral Energy Distribution by Planck's Formula." The set consists of seven sheets each about 24 in. $\times$ 19 in., printed on stout paper, the price being the very reasonable one of 35 cents. Of the sheets, five are charts, the remaining two a sheet of explanations and a sheet of tables. Table 1, which will be of use to the general physicist, gives values of the intensity of radiation E_λ for different values of $\lambda\theta$ (λ =wave-length, θ =absolute temperature), expressed as fractions of the value at maximum, which occurs for $\lambda=\lambda_m$, where $\lambda_m\theta=2890$. The values are given to four significant figures. Tables 2A and 2B give values of E_λ for λ from 0.4 μ to

0.72 μ , and for θ from 1000° to 2800°, the ordinates being on such a scale (different for each temperature) that $E_\lambda=100$ at 0.59 μ in Table 2A, at 0.56 μ in Table 2B. The five charts provide graphs corresponding to the second of these tables, the scale being altered from chart to chart so as to provide an accuracy of 0.33 per cent. in the energy values, 0.1 per cent. in the temperatures. From such curves it is a very simple matter to deduce the colour-temperature of a radiator from observations of the relative energies at 0.56 μ and one other wave-length. The graphs are on millimetre paper, and are very clearly executed. The value $C_2=14350$ is chosen for the radiation constant occurring in Planck's formula, though work done by Coblentz at the Bureau of Standards gave $C_2=14320$. It is shown, however, that this makes a negligible difference to the accuracy required, and in any case it is easy to use the charts in such a way as to allow for the difference.

METALLURGY IN ANCIENT MEXICO.—The method employed by the ancient Mexicans in the manufacture of certain metal objects has been repeatedly investigated with no very conclusive result. Strebel holds that although these objects have the appearance of wound wire welded or soldered together—and some were undoubtedly made by this process—the usual method employed was that of *la cire perdue*. They had not hitherto been submitted to microscopic examination. Dr. Axel Hultgren, however, has now applied this method of investigation to three exactly similar bronze bells from Nochistlan in Central Mexico, and has published the result in vol. 17, N.S. of the *Journ. des Américanistes de Paris*. Externally these bells have a grooved appearance suggesting that they have been made by winding a metal wire and subsequent welding, but internally they are perfectly smooth. An analysis of their composition gave copper 92.40, tin 6.95, lead 0.02, phosphorus 0.05, antimony less than 0.1, iron and aluminium less than 0.1. The microscopic examination showed the dendritic structure typical of cast alloys, and such as would be in accord with the chemical composition. The branches of the dendritic structure are the first formation of crystals in a falling temperature, and contain less tin than the material intervening between them which solidifies later. This proves, therefore, beyond question that the bells were cast. Had they been made from wire, the dendritic formation would have been distorted.

CONSTITUTION OF GLASS.—Prof. W. E. S. Turner has summarised the more important sections of our present knowledge of the nature and constitution of glass in a paper presented to the Society of Glass Technology and published in the Society's quarterly journal (September 1925). He has applied the Ramsay and Shields equation to the study of the molecular complexity of glasses with the aid of some data on surface tension and density, and has shown the fluid glass "molecules" to be of high molecular weight. Further investigation of the molecular complexity is developed by the application of indirect evidence. The existence of chemical compounds in glass has received attention, and the relation between percentage oxide content and the properties of thermal expansion, density, tensile strength, compression strength, etc., suggests that the oxides retain their individuality. The existence of breaks in the curves of composition—specific volume, etc., is taken as evidence of the presence of compounds. Much more investigation of physical and physico-chemical character is necessary before definite conclusions can be drawn. The same issue contains important communications from other authors on the constitution of glass.

Anniversary Meeting of the Royal Society.

IN his address on the occasion of the anniversary meeting of the Royal Society, held on November 30, the retiring president, Sir Charles Sherrington, referred to the heavy toll which death has taken of the Society since the last anniversary meeting. Brief mention was made of the lives and work of no less than twenty-three fellows and two foreign members who died during the past year. The president also spoke of the retirement of Sir William Hardy, biological secretary of the Society since 1915, on the completion of his statutory term of office.

The substance of the remainder of Sir Charles Sherrington's address is printed below.

The generous bequest of 10,000*l.* received last year from an anonymous donor for the promotion of medical research has this year, on the recommendation of the Tropical Diseases Committee of the Society, been resorted to for prosecuting investigation into the disease kala-azar, endemic in India and the Orient. At the instance of the Society, Major Patton and Dr. Hindle started for Northern China in June last in pursuance of that object. From the same generous and anonymous source a further munificent bequest has been received of something over 28,000*l.*, to be applied on the same terms and under the same condition of anonymity.

The Society, at the request of the Government, again organised, through a committee appointed for the purpose, an exhibition of pure science at the British Empire Exhibition. The catalogue of last year's exhibition was revised, enlarged and republished under the title "Phases of Modern Science." It is estimated that the Pure Science Exhibition was visited this year by at least 120,000 persons.

From the fund accruing to it in 1921 by the bequest of Miss Foulerton, the Society has this year been able, in pursuance of its scheme for advancing natural knowledge by the establishment of research professorships, to institute a further Foulerton Professorship, and the new Foulerton Professor appointed is Prof. A. Vivian Hill. Prof. Hill is already universally known as a most distinguished and fruitful investigator in animal physiology. He has placed the knowledge of muscular contraction upon a new footing. Taking up the problem from the viewpoint which chemical researches had at that time reached, Hill, by his own experiments, and experiments in conjunction with his pupils and others, has carried its study much further, especially in its physical aspects. The technique devised and the lines of analysis pursued have been masterly. He has attained preciser measurements, both of the energy changes and their time relations, and of the mechanical work realisable. Examining under various conditions the several ratios existing between these quantities, he has thrown fresh light upon the intimate mechanism of muscle. Not always has it been entirely welcome news that Prof. Hill has brought us about our muscles; we learn from him that they are sadly viscous machinery, but to that he reconciles us by pointing out compensatory advantages arising from that property. Deeper acquaintance with the principles underlying that function should enable better advantage to be taken of it. Some of Prof. Hill's results already touch practical issues. He is determining decisive factors concerned in the performance and maintenance of physical effort, and is tracing physiological characteristics underlying the skill and endurance of the athlete. Such researches promise information of value in regard to the management of muscular effort—and its application on a wholesale scale to industrial

labour. They also promise further insight into what may be termed manual skill. Prof. Hill's researches concern, therefore, questions of large practical as well as of theoretical importance.

As regards the biological papers brought before the Society during the past year, one feature which they display is that at this present time the growth of what one may term the experimental biological sciences—physiology, pathology, bacteriology, and pharmacology—is in some measure a convergent growth. Their individual boundaries seem more and more to merge. They are individual in their application rather than in their essential nature, and an advance made by one is of immediate advantage to all. Of any particular paper it would be often difficult, were it desirable, to say under which of these individual sciences it might best be singly classified or catalogued. Nor, under the elastic working of the Society, does that create difficulty; and that again affords evidence of the practical efficiency of our working arrangement.

With certain stages of growth there goes, on the other hand, increasing independence of an individual science. This seems so to-day for psychology viewed under the rubric of experimental biology. That psychology is rapidly growing is evident—not least so from its enhanced and successful application to practical problems lying before it in the sphere of industrial management and conditions of labour. Psychology as a part of experimental biology possesses, of course, recognised ties with the physiology and pathology of the nervous system; but on them it no longer explicitly leans to the extent it did. Its discipline becomes more intrinsically its own. This is, to my mind, well, and of favourable augury for its immediate progress as an experimental science. Concurrently with that tendency in psychology it is noteworthy that physiologists, Prof. Pavlov and his school, with, in Great Britain, Dr. Anrep, are pursuing analyses of complex behaviour of the higher animals under systematic avoidance of all reference, even by implication, to such psychical reactions as accompany that behaviour. Their method applies to animal behaviour in wider ambit than hitherto, the principles of reflex action. To illustrate by one example:—In his admirable Croonian lecture last June, Prof. Magnus described analyses by himself and his colleagues of the pure reflex behaviour of the cat without cerebral hemispheres. He showed how, for example, a moving mouse before the eyes of such a cat attitudinises the whole mechanism of the animal, exciting from it appropriate posture and direction in readiness for the final spring upon its prey. After that, "all the cat has to do is to decide to jump."

To jump or not to jump, that becomes the question. At such a point it is that the work of Pavlov and his school dovetails on to the work of Magnus and his school. Pavlov shows how in the intact animal such a final turning-point in its train of reactive behaviour—for example, "jump" or "not-jump"—can be studied as what is termed a "conditioned reflex"; he shows how that turning-point can be examined as the outcome of a balance between physiological impulsions and restraints, dependent partly on conditions under which the act is called for at the moment, partly on conditions under which it has been called for in the past—that is to say, the physiological history of the act in the individual, the mutual time-relations of the dominant stimuli, and so on. The result is thus treated as a sum of physiological factors, positive and negative, interacting under physiological rules, which can be determined, therefore, as obtaining from the

cerebral cortex. In this way is pursued a physiological study of higher nervous functions of the animal brain, without appeal to psychical reactions, of which, indeed, the method affirms nothing and denies nothing. To my thinking this line of attack is a gain both for physiology and for psychology, since psychology and physiology thus tread an essentially common terrain, yet do so each untrammelled by the other and without explicit reference to the eternal psycho-physical problem.

But it would be a far step, and a difficult, and of questionable gain, to carry such divorce of psychology and physiology into the study of fields such, for example, as human speech with what that connotes for reaction in the human brain. There it would seem better, as in Dr. Head's analysis of aphasia, to treat the anatomical, physiological and psychical data together. This seems the better, possibly the only, course of approach to those highest conjoint physiologico-psychological problems than which there can be few scientific problems which are of greater or more special interest to man.

PRESENTATION OF MEDALS.

THE COPLEY MEDAL: PROF. ALBERT EINSTEIN.

The name of Einstein is known to every one through the theory of relativity which he originated in 1905 and extended by a notable generalisation in 1915. Einstein realised that the time and space with which we are so directly acquainted by experience can be no other than the fictitious *local* time and space of the moving system—the motion in this case being that of the earth; we have no means of determining, nor can physical science be concerned with, any absolute reckoning of space and time. After this Einstein was led to the identification of mass with energy—another result of far-reaching importance, which allows us to know the exact amount of the store of energy so tantalisingly hidden within the atom.

There was a feeling that this theory of relativity for uniform motion must be a particular case of something more general; but observational knowledge seemed to oppose a decisive negative to any extension. It was Einstein again who found the way to the generalisation by bringing gravitation into his scheme.

Einstein's general theory of relativity is remarkable alike for the brilliance of conception and the mastery of the mathematical implement required to develop it. The new law of gravitation must be reckoned the first fundamental advance in the subject since the time of Newton. It involves an interaction between gravitation and light, which had indeed been suspected by Newton and almost taken for granted by Laplace, though it dropped out of scientific speculation when the corpuscular theory of light gave way to the undulatory theory. The three crucial astronomical tests of Einstein's theory have all been verified—the motion of perihelion of Mercury, the deflexion of light, and the red-shift of the spectral lines. The last-named proved the most difficult to test, but there is now general agreement that it is present in the solar spectrum. More recently Einstein's theory of gravitation has appealed to astronomers not merely as something which they are asked to test, but as a direct aid to the advancement of astronomical research. Invoked to decide the truth of a suspicion of transcendently high density in the "white dwarf" stars, it has decided that in the companion of Sirius matter is compressed to the almost incredible density of a ton to the cubic inch.

The other direction in which modern physical theory has broken away altogether from the ideas of the nineteenth century is in the quantum theory. Probably no one would claim that he really understands the quantum theory. For such illumination as we do possess we are in great measure indebted to Prof. Einstein. In 1905, almost at the same time as he published his first work on relativity, he put forward the famous law of the photo-electric effect, according to which the energy of a single quantum is employed in separating an electron from an atom and endowing it with kinetic energy. This was, perhaps, the first recognition that the development of the new quantum mechanics was not to be tied to classical mechanics by pictures of quasi-mechanical oscillators or other intermediate conceptions, but was to proceed independently on radically different principles. Noteworthy contributions followed on the theory of ionisation of material, and on the problem of the specific heats of solids. In 1917 Einstein reached another fundamental result—namely, the general equation connecting absorption and emission coefficients of all kinds. This gives deep insight into the origin of Planck's law of radiation, besides providing new formulæ with the widest practical applications.

A ROYAL MEDAL: PROF. WILLIAM HENRY PERKIN.

The science of organic chemistry owes a debt to Prof. Perkin, as instanced in recent years by his monograph on cryptopine and protopine, a record of chemical research rarely equalled in experimental skill and precise reasoning. He has revealed the constitutions of the alkaloids harmine and barmaline; he is nearing the solution of the structures of strychnine and brucine, two alkaloids which have hitherto resisted all attempts to determine their structural formulæ. His work on berberine has left few questions unanswered concerning the constitution of this important substance. He has developed new methods of attack on the chemistry of these natural products, and has faced many problems in structural organic chemistry. He succeeded, during a period of twenty years at the University of Manchester, in building up there a notable school of chemical research. During the past twelve years, in the University of Oxford, he has again organised and developed a similar research school.

A ROYAL MEDAL: PROF. ALBERT CHARLES SEWARD.

Prof. Seward's work has been conspicuous on account of the way in which he has extended and reduced to order our knowledge of the palæobotany of Gondwanaland, especially in India, South and Central Africa, Antarctica and the Falkland Islands. The lower stages of the Gondwana system are characterised by evidences of a glacial climate; and in order more completely to understand the conditions of life that existed, Prof. Seward has visited Greenland and otherwise paid special attention to the effect of climate and light in explaining the rise and luxuriance of the *Glossopteris* flora in the Southern Hemisphere. In addition to its direct stratigraphical value to geologists, his work has added greatly to our knowledge of plant migration, and especially of the way in which the *Glossopteris* flora invaded the Northern Hemisphere previously occupied by the groups familiar to us by our Coal Measure plants.

THE DAVY MEDAL: SIR JAMES IRVINE.

The constitution of the simpler sugars (monosaccharoses) was based on a sure foundation by the classical researches of Emil Fischer. Taking up the

investigation where Fischer had left it, Sir James has carried the inquiry into the more complex field of the disaccharoses, and by means of new processes, which he has been able to evolve and apply, to assign definite chemical structures to many of these most important natural products. He has also studied the constitutions of the still more complex polysaccharoses, starch and inulin, incidentally gaining an insight into the manner in which the plant forms and utilises these fundamental reserve materials.

THE SYLVESTER MEDAL: PROF. A. N. WHITEHEAD.

Always primarily interested in the foundations of mathematics, it is in the logical analysis of these foundations that Prof. Whitehead's reputation has been won. The great work, "*Principia Mathematica*," written in collaboration with Bertrand Russell, contains the most systematic and the most profound analysis to which the foundations of the subject have yet been submitted.

From pure mathematics both Prof. Whitehead and his collaborator have turned independently to physics. In his more recent books Whitehead has endeavoured to apply the spirit of "*Principia Mathematica*," and in particular the principle which he calls "extensive abstraction," in the more complicated and more con-

troversial field of physical existence. That a point, whether in the older physics or the modern physics of space-time, is a class, or a class of classes, of events, that an electron is a systematic correlation of the characters of all events throughout all Nature, are doctrines at which the unsophisticated may be tempted to scoff, but the tendency of modern scientific thought is to the conclusion that, if the world of physics is indeed ultimately capable of any rational interpretation, it must be interpreted in some such way.

THE HUGHES MEDAL: MR. F. E. SMITH.

Mr. Smith began work on the realisation of the fundamental units of electrical measurement in 1902; and such further experiments as have been made since have served only to confirm his results. Other important investigations by Mr. Smith have dealt with the measurement of terrestrial magnetism. The recording magnetometers which he designed have proved of great value, while more recently he constructed, at the suggestion of Sir Arthur Schuster, a horizontal force magnetometer of extreme accuracy. During the War his services to the nation were of great importance, and since the Armistice, as Director of Research at the Admiralty, he has been responsible for a number of valuable investigations.

The Conference on Solid Smokeless Fuel in Sheffield.

A CONFERENCE on solid smokeless fuel was held in the Department of Applied Science at the University of Sheffield on Friday November 20. To point the moral, a tasty fog prevailed throughout the proceedings. The meeting was under the joint auspices of the Society of Chemical Industry, the Institution of Chemical Engineers, the Institution of Gas Engineers and the Midland Institute of Mining Engineers.

The objects of the meeting were to discuss methods of improving the quality of high-temperature coke and the alteration to present equipment and to plant which is required for the purpose. Dr. C. H. Lander contributed a general résumé, and papers were read by Dr. E. W. Smith on "The Qualities Requisite in a Solid Smokeless Fuel for Domestic Use," Prof. R. V. Wheeler on "The Production of Free-burning Solid Smokeless Fuel at High Temperatures," Mr. E. V. Evans on "The Combustibility and Reactivity of Coke," Mr. D. Rider on "Coke Quenching," and Mr. F. M. Birks on "Coke Handling, Screening and Breaking." There were about three hundred present, and the meeting was highly successful. In addition to the papers, investigations under the direction of Prof. Wheeler in the Fuel Department were inspected. There was also a demonstration of ordinary coke burning in open grates and in a closed one.

Low-temperature processes have been discussed with some thoroughness, and consequently the position as to these is fairly well known. Briefly, there is no low-temperature process. Many are the systems on paper, few are on works-sized concrete foundations, none show appreciable returns to the owners. It may be said of all, that none have mastered their engineering difficulties, few know even part of the chemistry of their products, whilst the efforts of all the systems have made no impression on the fuel question. It is clear that a low-temperature process will have to pass through the difficulties attending the evolution of the high-temperature process without any of the advantages attaching to these statutory bodies.

Such being the case, and assuming a demand for a free-burning solid smokeless fuel, can anything be done to render high-temperature coke more combust-

ible and thus suitable for the domestic grate? If this can be done, then remembering that gas-works and coke-ovens together have an output of about 20 million tons of coke and that the domestic consumer consumes more than 40 million tons of coal per annum, the field for expansion is obvious. With regard to this scheme, it may be said that gas-works and coke-ovens do possess carbonisation technique, of a sort, capital has certainly been expended on them, they are old and tried servants.

If this were all, and provided high-temperature processes provide a free-burning fuel, then coke-ovens and gas-works have it. But it has yet to be proved that they can and will provide a coke that is easy to ignite, easy to keep alight, free from ash, low in moisture, clean and free from dust. But assuming that all this could be done and assuming that the combined output went to the domestic consumer—a very far-fetched assumption—only half of the domestic coal consumption would be displaced. A doubling of plant cannot reasonably be visualised within the next ten years.

Consequently there is still plenty of scope for low-temperature carbonisation, if the processes could be put on a commercial footing. Considerable interest was taken in low-temperature processes owing to the probable oil obtainable under these conditions. But a good deal more oil seems probable by the use of hydrogenation methods, the one process being yet as problematical as the other. Little is known of the composition of the liquid products of low-temperature processes. It is for this reason that low-temperature processes are desirable. It may well be that new classes of compounds may be brought to light with new properties and new uses. New drugs, new dyes, may be obtained, new substances with yet unknown benefit to mankind. Whatever the financial results from low temperature, the probable scientific results should be known.

The technical contributions to the subjects of the conference may be summed up in a short space, as was done by Prof. Wheeler. Fine grinding followed by blending, and the mixture of coals thus produced to be carbonised in narrow ovens under high-tempera-

ture conditions, the charge to be pushed when the centre of the coke reaches 700°C. , seem likely to produce a more combustible coke. This opinion is based on some theory, on a fair amount of careful laboratory experiments, with but little large-scale confirmation, however.

Of scientific contributions there were naturally few; naturally, because of the newness, vastness and difficult character of the field. Concerning carbonisation, profound ignorance prevails. As to treatment and events beyond the hydraulic main there is still room for discussion—witness the recent contribution to this by Dr. Smith and Mr. Finlayson—but in respect to treatment and events, from the cold coal to the hydraulic main, there is no useful discussion. We do not know. There is much methane in coal gas, the methane has presumably been at 1000°C. or so. At this temperature methane deposits carbon and produces hydrogen. The shiny carbon—termed methane carbon—is accompanied by at least two, if not more than two, physically different forms of carbon. Moreover, from the deposit, it is almost as easy to pick out pieces of naphthalene as it is pieces of carbon.

At the Conference the terms reactivity and combustibility were used as synonyms. Korrevar has shown that they are as synonymous as silica and glass. Mr. E. V. Evans brought forward a new method for the determination of the combustibility of coke, as regards the utility in the open grate, and the method promises much. But as to reactivity, that intrinsic property of carbon, not much was said. The reactivity of carbon, which lies at the basis of the combustibility of that impure substance, coke, depends on the physical condition of the carbon, and at once we are back to the carbon deposits from methane cracking. If we know nothing concerning these deposits of

carbon, what are we to say of our real knowledge of coke?

As Dr. H. M. Travers pointed out, at almost every stage of the carbonisation some very pertinent and unanswerable questions may be put. Why is primary tar formed at all—what is the mechanism of it? Why does coke at the later stages of carbonisation evolve hydrogen for the most part, and that in bursts with rise of temperature? He also put in a plea for research into fundamentals of fuel utilisation; if this be undertaken, then the Conference may well be a momentous one. He considers that the universities should undertake the work rather than, for example, the Fuel Research Board. His opinion is that progress is not likely to follow the permutations and combinations of well-known works processes. A difficulty is created, however, by the financial position of most of the universities of Great Britain. Many public-spirited industrialists know this, and there may be those, whether individuals or corporations, who would care to contribute towards the cost of research into fundamentals of this character.

Should means become available for the prosecution of the fundamental researches indicated, then a plea might be entered for the University of Sheffield, where there is a well-established school of fuel research. The list, distributed at the meeting, of work in progress, served to indicate the varied and extensive character of its activities. One could pass from Fuel Research Board apparatus, solvent resolution, to spontaneous combustion, momentary heating of coal, desulphurisation, combustion, coal constitution, synthetic ulmins, hydrogenation, flame work and microscopic work.

The Conference adjourned until February for a meeting at Manchester. S. L. B. ETHERTON.

The Early Nilotic, Libyan, and Egyptian Relations with Minoan Crete.

THE Huxley Memorial Lecture of the Royal Anthropological Institute for 1925 was delivered by Sir Arthur J. Evans at the rooms of the Royal Society on Tuesday, November 24. The chair was taken by Prof. C. G. Seligman, president of the Institute.

Sir Arthur Evans said Crete might be described as a half-way house between three continents, Europe, Asia, and Africa. Its fortunate situation marked it as the point where the primitive culture of our continent was first affected by the older civilisations of Egypt and the East. The most ancient geographical relations of Crete lay with Anatolia and the East. Man entered Crete from the Anatolian side; he may even have found the dwarf hippopotamus surviving from the times of the land-bridge of Miocene and Pleistocene times; but Palæolithic discoveries in Crete are still wanting and human remains from Neolithic times are still to seek. From Middle Minoan times a brachycephalic element is perceptible, mixed with the older dolichocephalic inhabitants, which may be due to an intrusion of "Armenoids" from Asia Minor, for which a portrait on a Middle Minoan seal supplies an argument. Archaeological, religious, and linguistic evidence all point to a root connexion between Crete and Anatolia. The primitive female steatopygous figures from the Neolithic strata of Knossos find remarkable parallels from Asia Minor and so far afield as the Euphrates and Caspian. Stone maces and monochrome pottery show similar affinities. The pre-Hellenic language is related to old Carian and its kindred tongues.

It has been supposed that Egyptian relics found in connexion with Minoan and Mycenaean Crete arrived

by the Syrian or Anatolian route, but this is unsupported by any evidence as regards the earlier contact of Crete with the Nile Valley. There is abundant proof that early man was not averse from deep-sea voyages. It is natural to suppose that in the East Mediterranean navigation began in the Aegean island world. Neither the Syrian nor the Libyan coast was favourable to its rise. Of Cretan vessels, the earliest representation is a clay model from Palaikastro of the First Early Minoan Period, which may be compared with the Nile craft such as those shown on the pottery of Naqada. There was a general use of sailing craft from an early date, and vessels with a single mast are of constant recurrence at the beginning of the Second Early Minoan Period in the first half of the third millennium B.C.

Evidence accumulating since 1890 of early relations between Crete and Egypt going back to the fourth Dynasty received remarkable confirmation from the beginning of the excavations at Knossos, in the form of imported Egyptian stone vessels of late prehistoric and protodynastic age and, more important, in derivative native Cretan forms in softer stone such as steatite and serpentine. In a Neolithic house of rectangular form found under the Central Court of the original Palace of Knossos, with fixed hearth of Anatolian type, was found among objects of pure Stone Age tradition a copper axe which must be regarded as an importation, not improbably from the Nile Valley. Two finds of special importance from this site were a gallipot-like vessel with clear traces of tubular drilling closely resembling a type of late predynastic and protodynastic Egyptian vessels, and two fragments of vessels of variegated stone which,

although like nothing found in Egypt or elsewhere, appear to be exotic and show that the Nilotic usage of stone vessels wrought in decorative materials had taken root at Knossos in the late Neolithic phase.

Among other elements of Cretan culture showing affinities to the early culture of the Nile and of the indigenous inhabitants of the opposite Libyan coasts, are the large stone ossuaries in the beehive form of the Messara plain on the southern border of the island, contrasting with the rectangular habitations of Crete. Stone idols from Hagia Triada curiously recall those found in predynastic Egypt. They show the high head and pointed beard of the Nilotic race, and possibly passed to Crete from Libya. The Cretan mode of head-dress and the type of loin clothing show either a resemblance or a general analogy with that of the Libyans. The Libyan Delta goddess appears to have been, in part at least, incorporated in the Cretan mother goddess, as is shown in the form of bow, arrows, and shield which are the attributes of the former. In

the stone ossuaries, the discovery of palettes of stone similar to those used by the predynastic Egyptians for antimony and malachite to adorn the person are peculiarly significant.

These striking correspondences in forms and usage, and especially in the contracted burials of the vaulted tombs of Messara, the dolichocephalic skulls, and the recurrence of foot-shaped amulets of stone, suggest a settlement of a proto-Libyan element in the southern foreland of Crete. These tombs are of a true beehive type, but they differ from the Mycenæan examples in their entrance system. They represent a sepulchral type which has a wide diffusion in the old Libyan region of North Africa. This proto-Libyan settlement became entirely assimilated in the Old Cretan population, but the engrafting of this artistic element on the indigenous island stock may well have contributed to the later bloom of Minoan culture.

At the conclusion of the lecture, the president of the Institute presented the Huxley Medal to Sir Arthur Evans.

The Flame Spectra of Carbon Monoxide and Water Gas.

TWO papers by Mr. F. R. Weston, recently published in the *Proceedings of the Royal Society* (A, vol. 109, 1925, pp. 176-186 and 523-526), embody the results of researches into the flame spectra of carbon monoxide, hydrogen, water gas, etc., which he has conducted at the Imperial College of Science and Technology under the joint supervision of Profs. W. A. Bone and A. Fowler. The object of the researches was to elucidate certain aspects of the combustion of carbon monoxide, and notably whether or not this gas interacts *directly* with oxygen in flames, a point which has been much disputed amongst chemists during the past forty years, but now seems to be in the way of being definitely cleared up by the spectroscopic

The spectrum of a flame of undiluted carbon monoxide burning in air (or oxygen) at atmospheric pressure is shown to consist of a banded radiation, extending from 5000 Å.U. in the visible region to 2200 Å.U. far in the ultra-violet, upon which a continuous spectrum is superimposed. Both the banded and continuous parts of the spectrum, which are associated with the characteristic colour and actinic properties of a carbon monoxide flame, are most probably due to *direct* interactions between carbon monoxide and oxygen molecules in the flame, without any intervention of steam. At the same time, unless both the carbon monoxide and oxygen are previously dried before combustion, the spectrum shows some characteristic "steam lines," due to interactions between CO and OH₂ molecules in the flame, which proceed simultaneously with, and independently of, the CO and O₂ interactions.

As the carbon monoxide in the burning gas was progressively replaced by hydrogen, both the banded and continuous parts of the spectrum rapidly faded away, until with an equimolecular (that is, 50 CO + 50 H₂ by volume) mixture of the two combustible gases

(water gas) only "steam lines" remained visible in the spectrum, the characteristic CO-radiation and flame-colour having almost entirely disappeared.

When a flame of undiluted carbon dioxide was burnt (undried) in oxygen under reduced pressure, the banded part of the spectrum became more distinct and the continuous part less intense as the pressure was diminished, the "steam lines" were invariably present in the spectrograms. When a flame of carbon monoxide, previously dried by passage through strong sulphuric acid, was burnt at atmospheric pressure in oxygen, similarly dried, the "steam lines" in the resulting spectra had almost disappeared (they were only faintly visible), whereas the intensity of the continuous part of the spectrum remained undiminished.

The conclusion drawn from the experiments is that in the flame of pure (undried) carbon monoxide two sets of independent interactions occur simultaneously, namely: (a) direct interactions between carbon monoxide and oxygen, exciting radiations which give rise to the continuous and banded parts of the spectrum, and to the characteristic blue colour of the flame, and (b) interactions between CO and OH₂ molecules, which originate the "steam lines" in the spectrum. When hydrogen is gradually added to the burning gas the relative proportions of the first-named interactions diminish rather rapidly and proportionately more of the carbon monoxide is burnt by interaction with OH₂-molecules, until when an equimolecular mixture of carbon monoxide and hydrogen is reached, the carbon monoxide-steam interactions occur to the practical exclusion of the carbon monoxide-oxygen interactions. These experiments have afforded the first clear evidence that in an ordinary carbon monoxide flame both sets of interactions are going on independently and simultaneously.

School Natural History Societies

THE Marlborough College Natural History Society is interesting as a school institution which has had an unbroken existence since 1864, when it was founded under the auspices of the then headmaster, later Dean Bradley of Westminster; it now issues its seventy-third printed report. Marlborough is situated in an unique position for this study, with some primeval forest in Savernake on one side and the

open savannahs of the Downs on the other. Between the two runs the Kennett, here quite a small sluggish stream noted for its excellent trout-fishing, with beds of willows and water meadows by its sides. Near its head waters, from six to seven miles away, lie Silbury Hill and Avebury, the latter with its immense stone circles. The Downs show dolmens and tumuli, most of the latter probably of much later age, and there

are numerous remains in camps, etc., of Roman times. The Report contains an account of excavations on the Wansdyke where it approaches Savernake Forest, and Mr. A. C. Brentall contributes a description of Martinsell, an old camp or cattle enclosure, three to four miles away, on the top of a chalk hill which falls precipitously to some of the richest agricultural ground of Wilts. Flint implements are common everywhere, as shown in an article by J. G. D. Clark, comparing 2000 specimens collected within two years at Marlborough and Seaford.

The permanent value of the whole series of reports lies, however, mainly in their descriptions of the natural history of one of the richest areas of the British Isles. The foundations of these were laid by such men as Preston and Hart-Smith in botany, Warde Fowler and Im Thurn (of British Guiana fame) in ornithology, and, above all, by Edward Meyrick in entomology, the latter not only a genius in his scientific work, but also in his task as a schoolmaster of developing the individuality of his pupils. Of the same type would appear to be Mr. A. G. Lowndes, who has written an illustrated article on that peculiar shrimp-like freshwater Cheirocephalus, a relic of the primary period; he also contributes notes on other freshwater forms that he and his class are studying, while there are references to vacation parties taken to the Isle of Purbeck and to the laboratory of the Marine Biological Association at Plymouth.

Of other work we might refer to meteorological observations carried on for sixty years, to the flowering dates of plants and to the dates of capture of insects, regular features of the report. In these a boy, A. G. P. Michelmores, seems to be prominent, and he, too, is largely responsible for revised lists of several groups of insects within a ten-mile radius of Marlborough, really the record of 663 species of that very difficult group, the Diptera or flies, is extraordinary for a school natural history society.

In this age of systematised school games—organised exercise would be a better term—we particularly welcome a report such as this, showing individuality, sacrifice and keenness in both masters and boys. Nothing gives a greater zest and interest to one's later life than the art of observation of all one's surroundings, both large and small, taught perhaps best in natural history. We are, indeed, happy to see that in this great school there must be opportunities for healthful and profitable recreation apart from the compulsion of "games."

University and Educational Intelligence.

CAMBRIDGE.—Mr. F. B. Smith has been reappointed reader in estate management for five years as from October 1.

The Raymond Horton Smith prize for 1924-25 has been divided between Dr. J. H. Burn, of Emmanuel College, whose thesis was written on the effects of denervation of a limb, and Dr. G. A. Harrison, of Gonville and Caius College, who dealt with insulin and diabetes mellitus.

The University Commissioners have published a list of amendments to their recently proposed statutes. The department of forestry is to be grouped with agriculture in a joint faculty. The Financial Board is to have power at its discretion to require that a departmental imprest account shall be administered by some one other than the head of the department. This might prove to be a valuable controlling factor in the case of any department the finances of which did not at any time appear to be administered in the best interests of the University. A special exception to the statute which requires professors to retire at the

age of sixty-five years is to be made in the case of Sir Humphry Rolleston, Bart., who accepted office at a time when the commissioners had intimated that they proposed to institute a retiring age of seventy years.

The Special Board of Agriculture and Forestry has presented a report of progress for the year 1924-25. The considerable number of students who obtained Imperial and commercial appointments is of great interest. Accounts are appended detailing the expenditure on research of about 38,000*l.* from the Development Fund of the Ministry of Agriculture.

LIVERPOOL.—Some relatives and friends of the late Sir William A. Herdman have founded a memorial scholarship at the University. This is open to graduates of British universities who are prepared to carry on research in marine zoology at Liverpool and at any British marine biological station. The scholarship has a present value of about 50*l.* per annum. Applications should be made to the Registrar before the first day of the summer term.

We learn from the Paris correspondent of the *Times* that degrees of doctor *honoris causa* have been conferred at the Sorbonne upon the following, among others: Sir Ernest Rutherford, Cambridge; Mr. Noguchi, Rockefeller Institute, New York; Prof. I. P. Pavlov, Leningrad; M. Charles de la Vallée Poussin, Louvain; and Prof. Ettore Pais, Rome.

THE Committee of Award of the Commonwealth Fund announces that it is now prepared to receive applications for the fellowships to be awarded in 1926. The fellowships will normally be tenable at an approved American university for two years and are open to persons of British birth domiciled in England, Scotland, Wales, and Ireland who are graduates of recognised universities and are unmarried and not more than thirty years of age. Women as well as men may apply. Provision amounting to approximately 600*l.* per annum will be made for the total expenditure involved during the tenure of a fellowship. Applications must be forwarded through the authorities of the university or college of which the candidate is or was a member. The form of application can be obtained from the Secretary to the Committee, Mr R. H. Simpson, 50 Russell Square, London, W.C.1. Applications must reach the Secretary by February 20 next.

THE effect of continuation classes on mill personnel was discussed at a luncheon meeting of the Lancashire Section of the Textile Institute on October 9. Mr. John Crompton, of Messrs. Burgess, Ledward and Co., Ltd., read a paper on this subject, which is published in the October number of the Institute's journal. Mr. Crompton makes out a strong case for the general adoption of the system of continuation classes, concurrent with workshop practice, for which the "Fisher Act" provides. The data on which he bases his arguments are derived chiefly from the experience of his own and other firms in employing boys and girls attending the continuation classes held in the Worsley Technical School, Walkden. He explains in detail how he has met the difficulty arising from machines being vacated by one set of operatives and requiring to be tended by others. He points out that at Rugby, the only town in England where day continuation schools are compulsory for all employees under the age of sixteen years, there is no juvenile unemployment, 90 per cent. of the employers pay wages for school attendance, 75 per cent. of the young persons attend voluntarily evening school activities in addition to the compulsory day classes, and these classes are proving the best method of establishing contact and oversight of a considerable

proportion of the population after the school-leaving age. "The managers of several works declare that the day continuation school is the best form of welfare effort, and that the humanising influence of real education is the only true welfare work."

THE annual meeting of the Geographical Association will be held on January 7-9 at the London School of Economics, under the presidency of Mr. W. G. A. Ormsby Gore, who will take as the subject of his presidential address "The Economic Geography of the British Empire." The very full programme includes lectures by Prof. J. L. Myres, on "Wayside Geography," by Sir John Russell, on "Cotton and the Nile," by Sir Halford Mackinder, on "The Teaching of Geography," and by Prof. P. M. Roxby, on "The Concept of Natural Regions in the Teaching of Geography, with special illustrations from China." University teachers of geography will hold a discussion on the compatibility of the training of the geographer with the acquisition of a university degree in geography, to be opened by Mrs. Ormsby, on the first day of the meeting, while on the last day there will be the following four concurrent discussions, the opener's name in each case being given in brackets: The place of geography in a two period a week geography course (Mr. C. G. Beasley), detail in geography lessons (Mr. C. Daryll Forde), geography in relation to other school subjects (Major A. G. Church), and geography for the younger children in primary schools (Miss R. M. Fleming). The afternoon of January 9 will be given over to excursions; arrangements have been made for (1) a walk across Hampstead Heath and a visit to the geography rooms of the William Ellis and Henrietta Barnett Schools, (2) a visit to the Science Museum, South Kensington, and (3) beating the bounds of the City of London under the guidance of Mrs. Ormsby. A publishers' exhibition of books of maps has also been arranged.

FROM the International Federation of University Women we have received a copy of the report of the Council meeting held at Brussels in July last. The list of constituent national federations comprises 23 countries, those with the largest membership being the United States of America (22,000), Great Britain (2000), Canada (1500), Australia (600), Ireland (350), South Africa (326), France (290), Switzerland (260), and New Zealand (250). Germany is not included. An application for affiliation has been received from Ukrainian university women, some of whom are in the Soviet Republic of the Ukraine and some in Poland. The most valuable of all the Federation's efforts for promoting intercourse are, says the president (Dean Gildersleeve of Barnard College, Columbia University), plans for fellowships and club-houses. For fellowships a campaign has been started for a "Million Dollar Fund." Awards have recently been made to Dr. Ethel McLennan of Australia, who is undertaking research work at Rothamsted, and to Dr. Elsa Mahler of Switzerland, who is continuing at Rome, Florence, and Arezzo, her work on Megarian bowls. For 1927 the Australian Federation offers two fellowships of 500*l.* each, one to be awarded to a non-British member of the International Federation and the other to a British member (excluding residents in Australia or New Zealand). There are international club-houses at which special privileges are offered to all travelling members of the Federation from other countries at Baltimore, New York, Philadelphia, Washington, Brussels, Montreal, Paris, Lyons, and London. The biennial conference of the Federation will be held in 1926 at Amsterdam and will include discussions of academic research, application of research to social problems, adult education, etc.

Early Science at Oxford.

December 7, 1683. Glass is found to be electrically only in ye cold, not by ye fire.

Dr. Plot gave an account of severall sorts of seeds, roots, leaves &c. brought from ye East Indies, and presented to ye Royal Society by Captain Knox. It having been affirmed, that probably seawater may be sweetened by being distilled from salt of Tartar, it was ordered to be tried how far ye distillation of brine from salt of Tartar might go towards ye sweetening of ye brine. It was ordered to be tried, whether Iron-ore melted, and cast into an ingot, lying north, and south, will acquire a verticity? As also whether water will bubble, after that a fire has, for some considerable time, been made over it, in like manner as it does when it boils by reason of a fire under it.

A letter was read from Dr. Antony Nuck, Anatomy Reader at the Hague, to Mr. Benbrig; wherein he promises to communicate to the Society, what Curiosities fall under his observation.

1686. An observation of ye Reverend Mr. Peck, Minister of Mayfield in Sussex, concerning a Gentleman who had been long in the East Indies, and about a month after that he took ship from thence, was taken with a fainting *feaver*, and various indisposition, had a vein opened; the *bloud* was squeezed out, and did accumulate like drops of melted wax: this gave releif, but about 3 weeks or a month after, his distemper returned; he was bled again; and thus his distemper and his bleeding continued for some years. In ye intervals he was well. He was cured by chewing Rhubarb.

December 8, 1685. Dr. Plot presented a piece of Ebony from St. Christopher's; it is yellow after ye saw, and blackish after ye plane, and is ye heaviest wood, we have yet seen.

There being some discourse concerning ye antiquity of weighing things in air and water, Dr. Bernard was pleased to informe ye Society, that that method is mention'd in ye Misna.

Dr. Plot also shew'd ye Society some little stones found by Mr. Lloyd on a bank by ye wayside south of Islip Church; they are ye same with those described by Dr. Lister, only these had no side indented.

The Circulation of ye blood appearing most evident to sense in some partes of ye *Lacerta Aquatica* viewed through a microscope (which we must in justice own to have receiv'd first from ye minutes of ye Dublin Society) the tryall of this experiment before this Society was recommended to Mr. Hoy.

December 9, 1684. A Paper was presented, by Mr. Desmastes, making mention of ye Trial of some Experiments found in Kunckel, vizt: That spirits of wine and syrup of violets make a green;

That Spirit of wine, and Milk, in equall parts, curdle; and

That a few drops of Water and Spirit of wine, heat perceptibly

A sheet of paper was presented ye Society, made of ye Asbestos-Stone by Mr. Lloyd, Register to the Chymicall courses of ye Laboratory of Oxford. The paper was made thus.

Mr. Lloyd received a parcell of this stone from the Isle of Anglesey, part of which he pounded (crude as it was) and carrying it to a paper-mill, had it mixt with water in their troughs for that purpose; then taken up, like their other matter for paper, it ran together. But ye lint being heavy, and quickly subsiding they were forc't to stirr it often, and be very quick in their operation. It was thought it might be made much finer and whiter, if it could be made stronger and tough, so as to be fit for any use.

Societies and Academies.

LONDON.

Geological Society, November 4.—N. E. Odell: Preliminary notes on the geology of the eastern parts of central Spitsbergen; with especial reference to the problem of the Hecla Hook formation. Approximately, the area amounts to 2000 square miles, but only a relatively small portion of this could be actually examined. It consists of a mountainous tract much of which is submerged under "highland ice" and glaciers, and is therefore lacking in direct rock-evidence. But through this ice-covering break many "nunatakkar," and, on the west of the region, a high range of mountains—the Chydenius Range—of which Mount Newton (5445 feet) is claimed to be the culminating point of Spitsbergen. The rocks encountered include representatives of the metamorphic basement complex, the Hecla Hook formation (which is intimately associated with that complex), the Carboniferous system, and intrusive acid and basic igneous facies. No evidence was found of rocks earlier in age than the Hecla Hook series, and an Archæan formation must be presumed absent. The greatest acid intrusions are those of the pink and grey granites in the Mount Newton and Mount Chernishev massif, both of the pre-Carboniferous (and presumably pre-Devonian) age. They would appear to have been intruded at the time of the Caledonian folding, and though towards its close, yet prior to the earliest Devonian sedimentation. Except in the south, on the Nordenskiöld Glacier, the Devonian strata are entirely absent, having been eroded from the interfolded Hecla Hook sediments and granites before the transgression of the Upper Carboniferous sea. The Carboniferous is confined to the coast of Hinlopen Strait, from Cape Fanshawe so far south as Bismarck Strait, while Triassic deposits were not seen north of the latter.—K. S. Sandford: The geology of North-East Land (Spitsbergen). North-East Land is separated by a narrow strait from the main island of Spitsbergen, and is about 8000 square miles in area. A great part of the coast and the whole of the interior are completely hidden by ice, which forms a dome rising to about 2400 feet. The northern area consists of Older Palæozoic rocks, granite, and gneiss; the last two being probably younger than the ancient sedimentary rocks. A pink granite penetrates them, and has been found extensively developed in the southern part of this "northern oldland." An important discovery in 1924 was the south-eastern corner of this pink granite, in the middle of the east coast, which previously had been known only as an unbroken and precipitous ice-front over 100 miles long. The southern area of the Island is delimited from the northern by an east-and-west fjord. This is an area of undisturbed Upper Carboniferous and Permian-Carboniferous clays and cherts, to a visible thickness of more than 1000 feet: the fauna belongs to the Russian Province. The history of the Island has been one of quiescence and immunity from folding, in an area of shallow seas. It has been affected by vertical movements, also by acid intrusions (Palæozoic) and by basic intrusions (Cretaceous).

Royal Anthropological Institute, November 10.—J. P. T. Burchell: The "shell-mound" industry of Denmark as represented at Lower Halstow, Kent. The stratified finds made during 1924 in the coastal sections between Swalecliffe and Reculver upon the north coast of Kent consisted of a medieval midden

of the fifteenth century containing roughly worked flint instruments for the purpose of opening up the shells of the oyster, cockle, whelk, and winkle; a midden of the Roman period containing pottery fragments, in addition to a series of occupation sites of the Early Iron Age in which were found several types of the pottery of that period accompanied by a few flint implements and flakes. A flint implement of Early St. Acheul times was found in the underlying Pleistocene gravels. This is the first instance of an implement being found *in situ* in these particular gravel sections. Further excavations were carried on during the current year. The site in question is on the western side of a tongue of land running out northwards into the centre of the Upchurch Marshes. Here, resting upon the surface of the London Clay, is a factory site of the Shell Mound period. This site consists of a series of circular patches 3 feet to 4 feet wide and 3 inches to 4 inches deep. They are composed of blackened earth and calcined flints. The implements occur most freely in these patches. The characteristic implements of the industry are the adze and "shell mound" axe or tranche, whilst flakes, cores, core scrapers, core dressings, chisel-ended flakes, blades, discs, borers, points and scrapers of the end, round, side and hollow types, are well represented. A round quartzite pebble with both faces countersunk and two opposing ends much bruised was also found.

Optical Society, November 12.—S. A. Emerson: Some recent improvements in modern ophthalmic lenses. The paper discusses the limitations inherent in the usual forms of fused bifocal lenses, and the methods now being adopted for overcoming these limitations. In the newer bifocals the glass used for the reading segment has the same relative dispersion as that of the major lens. The fused lens has thus no more chromatic aberration in the reading portion than has an ordinary single lens of the power of the reading portion made from either glass. In the fused bifocals as usually made there is very limited control of the centering of the reading portion. By using suitably shaped reading portions, this difficulty has been largely overcome. For medium and high-power lenses, a reduction in weight and an improvement in appearance, together with an increase in the field of view, have been obtained.—W. Swaine: Relation of visual acuity and accommodation to ametropia. Artificially produced results on the author's own eye are compared with his theoretical table showing how degrees of ametropia affect visual badness (*i.e.* inverse of acuity).—H. H. Emsley: Irregular astigmatism of the eye—effect of correcting lenses. Experiments to test the grating acuity of the eye in different meridians reveal the presence of irregular acuity, or irregular astigmatism as it is called.—E. F. Fincham: Some causes of apparent astigmatism of the eye, other than cylindrical errors of refraction. Measurements of visual acuity of a hypermetropic eye were made with a grating test. These showed that although the eye was able to make the necessary adjustment of the accommodation to correct the hypermetropic error for any meridian, the acuity varied considerably in different meridians. Variations of acuity in different meridians can be explained upon the assumption of the presence of "veins" of unequal refractive index in the media, or the striated character of the crystalline lens. Owing to the hexagonal packing of the foveal cones, the separation of their outer extremities (presumably the sense organs) is different in different meridians. The separation is least in the three meridians in which lie the centres of adjacent hexagons.

DUBLIN.

Royal Dublin Society, October 27.—L. B. Smyth: A contribution to the geology of Great Orme's Head. Great Orme's Head in North Wales consists of at least 1230 feet of Carboniferous limestone. The uppermost 180 feet are nearly barren, cherty limestones. They rest upon 50 feet of dark limestones and shales, the Bishop's Quarry beds, with a considerable fauna, including *Productus giganteus* (Mart.) in prodigious numbers, and *Posidonomya becheri* (Bronn.). Correlation is suggested with "Upper D₂" (Lamellibranch beds) of Garwood and Goodyear in the Craven district. The next 700 feet consist of pale to white limestones, graduating below to dark brown, with a few shales at the base. The latter have a fauna containing D₁ and D₂ forms. Below these shales all the limestone is dolomitised and no identifiable fossils were obtained. The thickness of the dolomite exposed is apparently 700 feet, but, owing to faults, may be only 300 feet. The base is hidden. One new species, *Chsiophyllum delicatum*, is described. Contemporaneous erosion is indicated at five horizons by the occurrence of local unconformities, limestone conglomerate, and current-bedded limestones and sandstones. The anomalous position of a mound of cherty limestone is probably due to transport by ice.

EDINBURGH.

Royal Society, November 9.—J. W. Gregory: (1) Scottish drumlins. Kames and drumlins are two of the most familiar features in Scottish scenery due to glacial deposits. Drumlins are elongated mounds of boulder clay which generally occur in parallel series and each has a steep broad bluff at one end, and tapers gently at the other. This form has been often attributed to the direct action of the ice by the deposition of the clay around a core of closely packed boulders. It is generally stated that drumlins are parallel to the direction of the ice movement. The Scottish drumlins have no such boulder core, and they are generally oblique to the ice movement, and are often at right angles to it. They are parallel to the prevalent wind direction as shown by the bending of the trees upon their crests. They are regarded as the characteristic form developed by boulder clay under the combined action of wind and rain. Some drumlins rest upon a core of rock which then determines their alignment; in these cases the effect of wind erosion is often shown by the development of secondary drumlins on the sides of the major drumlins. (2) Scottish kames. Kames are ridges of sand and gravel deposited during the melting of the ice sheets of the glacial period. They have been often identified with the Swedish osar and attributed to deposition in rivers flowing under or through glaciers. The distribution of the Scottish kames—excluding formations so-called which are moraines, drumlins, or banks left by the denudation of sheets of gravel—gives no support to this view, but shows that, like the ordinary Irish eskers, the American kames and similar formations in Finland, they were deposited as banks of gravel on the margin of an ice sheet melting in water. The chief Scottish kames occur at intervals along a line through eastern Scotland from Caithness to Berwickshire. They are all earlier than the 100-ft. raised beach except one at Dornoch. They are absent from the Highland Plateau, on which they would be expected to occur if due to sub-glacial rivers.—J. M. Wordie: Notes on the geology of Jan Mayen: The bulk of the island consists of lavas of basaltic composition, for the most part trachy-basalts; but among the early eruptions trachytes and andesites are found. In

places there are great thicknesses of tuff, and sills of basic constitution are everywhere prominent. Beerenberg (8090 ft.) has never been active in historic times.—G. W. Tyrrell: The petrography of Jan Mayen. The Jan Mayen lavas consist of a mildly-alkalic series ranging from ankaramite (ultrabasic olvine-basalt), through trachy-basalts of various types, trachyandesites, to trachytes, of which seven new chemical analyses have been made. The suggested sequence of eruption is trachyte, trachy-basalt, and ankaramite, due to the downward freezing of a gravity-stratified magma.—Martin A. Peacock: The geology of Videy, S.W. Iceland; a record of igneous action in glacial times. The basement-rocks of Videy are a disturbed, downward succession of palagonite-tuff and breccia with included glacial blocks, "globular basalt" (akin to pillow-lava), and fine-grained, shattered basalt. Their structural and petrographic peculiarities may be explained by assuming that they were formed by "sub-glacial extrusion."

PARIS.

Academy of Sciences, October 19.—J. Costantin: An unsuspected case of plant pathology.—d'Arsonval; F. Bordas and F. Touplain: The determination of the régime of mineral springs. A description of automatic instruments used for recording the temperature and output of the spring, and for taking a sample when a determined temperature is attained.—Riquier: Some problems relating to the partial differential equation $(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2})u = 0$.—A. Calmette,

J. Valtis, L. Nègre and A. Boquet: Experimental infection through the placenta by the filtrable elements of the tubercular virus. Under certain experimental conditions the filtrable virulent elements arising from tuberculous products or from cultures of Koch bacilli, inoculated under the skin of guinea-pigs, can pass through the placenta, infect the fetus and determine tuberculous lesions.—Paul Mentré: The simultaneous projective deformations of a congruence and of its two focal surfaces.—André Roussel: The method of adjunction of the calculus of variations.—Const. Parvulesco: The distribution of the stars in the globular clusters M.9, M.10, M.12, and the kinetic theory of gases.—Georges Fournier: The period of decay of radium E. The values found by the author, 4.86 days and 4.84 days, confirm the earlier results of Thaller (4.85 days), and are not in agreement with the recent figure of 4.98 days found by Bastings.—Jean Jacques Trillat: A method, using X-rays, by means of which the course of certain chemical reactions (the oxidation of unsaturated fatty acids) can be followed. A thin layer of the unsaturated acid was placed on a sheet of lead, and X-ray spectrographs taken at intervals. By this method the steps in the oxidation of oleic, linoleic and linolenic acids can be studied. The oxidation is brought about by successive additions of the same quantity of oxygen; and is accompanied by a molecular elongation of the order of 6 or 7 Å.U. This elongation renders the system unstable and is followed by polymerisation.—Fred Viès and Mlle. Madeleine Gex: The behaviour of benzene in the presence of aqueous solutions: the ultra-violet absorption as a function of the pH. The experimental results are given as a curve, showing the ratio of the absorptions $[\lambda 260]/[\lambda 254]$ as a function of the pH. The benzene molecule is not inert towards the hydrogen ions of the solution.—H. Forestier and G. Chaudron: The points of magnetic transformation in the system ferric oxide-magnesia. The study of the relation between temperature and

the magnetic properties of mixtures of ferric oxide and magnesia prove the existence of magnesium ferrite, $\text{MgO} \cdot \text{Fe}_2\text{O}_3$. Ferrites of nickel, lime and cadmium, which are attracted by a magnet, have also been prepared.—A. Boutaric and Mlle. G. Perreau: The influence of some stable colloids on the flocculation of sols and of suspensions.—J. L. Costa: The mass spectra of some light elements. The values found are for hydrogen 1.0074 (positive ion) or 1.0079 (neutral atom); lithium 6.009 and 7.012.—Francis Perrin: The Brownian movement of rotation.—Picon: The action of a vacuum and of heat on the neutral and basic nitrates of bismuth. The estimation of the water of constitution and of nitric acid in these salts.—Const. A. Ktenas: The eruption of the volcano of Santorin. The morphological characters.—René Souèges: The embryogeny of the Crassulaceæ. Development of the embryo in *Sedum acre*.—Marc Bridel: The presence of two new ferments, primeverosidase and primeverase, in the emulsion of almonds.—G. Rivière and G. Pichard: The posterity of *Amygdalopersica Formontii*.—René Hazard and L. J. Mercier: The action of tropanol on the heart.—Armand Dehorne: Indications on the inome of some cellular categories.—M. and Mme. Georges Teissier: The embryonic growth of *Chrysaora hysocella*.—Samec: The enzymatic hydrolysis of natural and synthetic amylophosphates.—Agasse Lafont and Roger Douris: The subcutaneous injection of gaseous substances such as oxygen.

SYDNEY.

Royal Society of New South Wales, September 2 — A. R. Penfold: The essential oil of *Eriostemon myoporoides*. This Rutaceous plant occurs along the coast to tableland districts of New South Wales, Victoria and Queensland, being very abundant at Emu Plains in the former State. The leaves and terminal branchlets yielded 0.75 per cent of a very mobile yellow oil. Its principal constituents proved to be d-a-pinene (75-85 per cent), ocimene, Ledum camphor, m.pt. 104° C., a sesquiterpene resembling aromandendrene, methyl anthranilate, a paraffin of m.pt. 64°-65° C., with traces of a phenolic body.—Sir George Knibbs: The human sex-ratio and the reduction of masculinity through large families. The live births in all western countries show an excess of males, and still births an even greater excess. Multiple births show greater femininity than ordinary. In Australia the proportion of females increases with the size of the family; thus in families of 1 to 3 there are 391 more boys than girls in 10,000 children; in families of 4 and 5 only 317 more; in families of 6, 7, 8, and 9 only about 246 more; in families of 10, 11, and 12 only 235 more. Taking the size of family given in "Who's Who," and using about half of the entries, the proportion is almost exactly what could have been predicted solely from the methods of probability, assuming equal chances for males and females. For example, in families of seven, the numbers for 7 boys, 6 boys and 1 girl, 5 boys and 2 girls, 4 boys and 3 girls, etc., were actually as on the top line

1	5	15	26	23	21	6	1
1	5	16	27	27	16	5	1

The bottom line shows what might have been expected from probability. The masculinity, however, while it falls on the whole, is somewhat variable. There is a difference in the relative number of males in the living and deceased issue of families of from 1 to 9. The Australian results are based on 81,375 families and 454,372 children.—G. J. Burrows and A. E. James: Molecular solution volumes and association. A comparison of the solution volumes

of several solutes in benzene, toluene, methyl alcohol and acetone suggests that the molecular solution volume is always greater in non-associated liquids such as benzene than in associated liquids such as methyl alcohol. When the solute is not associated the difference is small, but in the case of an associated solute there is a marked difference between its volume in benzene or toluene and that in alcohols or acetone. The molecular solution volume of a non-associated solute in any of these liquids does not differ very much from the molecular volume of the solute in the liquid condition, whereas an appreciable difference is observed in the case of an associated solute dissolved in an associated solvent.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 11, No. 10, October).—Francis G. Benedict and Elizabeth E. Crofts: The fixity of basal metabolism. For a normal subject, half an hour's repose is sufficient to establish a condition giving trustworthy measurements of basal metabolism on any individual day. Even when exposure has reduced the skin temperature considerably, oxygen consumption measurements indicate that heat production is unchanged and thus independent of heat loss.—Tracy Yerkes Thomas: (1) Announcement of a projective theory of affinely connected manifolds. (2) On the equi-projective geometry of paths. Most of the theorems have their counterpart in the affine geometry of paths.—H. P. Robertson: Transformations of Einstein spaces.—Otto Oldenberg: On fluorescence radiation of nitrogen. A condensed spark arrangement is included inside a bulb containing the gas at very low pressure, and a ray from the spark excites faint fluorescence along its path. The fluorescence has a pure band spectrum containing bands due to the fluorescing ion and the fluorescing molecule.—A. H. Compton and R. L. Doan: X-ray spectra from a ruled diffraction grating. The grating was ruled on speculum with comparatively large grating spaces ($D = 2.000 \times 10^{-3}$ cm.), and light ruling and very small glancing angles were used. Wave-lengths measured thus agree well with those obtained by reflection from a crystal.—Ralph D. Bennett: An attempt to test the quantum theory of X-ray scattering. Simultaneous registration of a recoil electron and a scattered X-ray quantum, at the angles predicted by Compton's theory, would be favourable evidence. Using Geiger point discharge counters and a solid, or hydrogen or air as a scattering target, co-incident effects were obtained, but they occurred in groups.—P. W. Bridgman: (1) The viscosity of liquids under pressure. For water, at low temperatures viscosity decreases with rising pressure to a minimum and then increases. This minimum disappears above about 25° C. All other liquids examined show uniform increase of viscosity with pressure, at first linearly but above 1000 kgm./sq. cm., the rate of increase grows rapidly, and generally the logarithmic curve becomes nearly straight. The temperature coefficient of viscosity also increases with pressure. (2) Thermal conductivity and thermo-electromotive force of single metal crystals. Thermal conductivity and thermo-electromotive force for bismuth, zinc, cadmium, and tin crystals for the range room-temperature to 100° C. were measured as a function of direction in the crystal. The results lead to the conclusion that there is a reversible absorption of heat within the crystal on changing the direction of the current (internal Peltier heat effect).—H. B. Wahlin: The aging effect in the mobility of positive ions.—J. H. Van Vleck: On the quantum theory of the polarisation of resonance radiation in magnetic fields.—H. C. Urey: The structure of the hydrogen molecule ion.

The energy is calculated of the steady state of lowest energy of the hydrogen molecule ion, when the electron vibrates in a straight line perpendicular to, and through the mid point of, the line joining the nuclei.—Albert L. Raymond: The mechanism of carbohydrate utilisation. The steps in alcoholic fermentation are, briefly, hexose monophosphate ester, cleavage into two triose groups, one containing all the phosphorus, the latter becoming hexose diphosphate and the former yielding alcohol and carbon dioxide; and the hydrolysis of the diphosphate back to hexose. Carbohydrate metabolism in the animal is believed to be similar.—William D. Harkins: The separation of chlorine into isotopes (isotopic elements) and the whole-number rule for atomic weights. By diffusion through the walls of clay pipe-stems, hydrogen chloride was obtained containing chlorine of atomic weight 35.477, as compared with 35.4574 for ordinary chlorine. It is hoped to investigate with this light fraction the spectral shift due to isotopes as found for ordinary lead and the lead produced by disintegration of uranium.—William D. Harkins and W. G. Guy: The radio-activity of potassium, rubidium, and other elements. The natural leak of a large ionisation chamber is balanced against that of a small chamber containing uranium oxide covered with aluminium foil to exclude α -radiation. The salts examined were placed in the large chamber, and the activities of rubidium and potassium found are as 1:39:1.00. It is concluded that the disintegration of an isotope is the source of the radiation from potassium.—William D. Harkins and Norvil Beeman: The oriented wedge theory of emulsions. If the oil-like or non-polar end of the soap molecule is smaller than the polar end, the emulsion will be one of oil in water; if the reverse be the case, the droplets will be of water. The size of the greatest number of drops is so much greater than the size of the sodium oleate molecule that it cannot be expected that the molecule should determine the size of the drop. Emulsifying agents, the molecules of which have larger non-polar or polar ends, are required to test the theory.—Williams D. Harkins and J. W. Morgan: Polymolecular and monomolecular films. Young's modulus for steel being about 12,000, that of a monomolecular film such as stearic acid on water is 39; a polymolecular film is generally much weaker. Films of mixed substances each giving a monomolecular film are also monomolecular.—William D. Harkins and S. B. Stone: The isotopic composition of the element chlorine in the meteorites: the atomic weight of meteoric and terrestrial chlorine (see NATURE, September 19, p. 426).—George L. Clark, P. C. McGrath, and M. C. Johnson: The effect of X-rays on the platinum catalyst in the contact sulphuric acid reaction. X-rays do not improve the yield if dry air is used. With moist air, an enormously greater conversion is obtained which is further increased, but only temporarily, by radiation of the catalyst.—Wm. H. Gates: The Japanese waltzing mouse, its origin and genetics. Both the waltzing and non-waltzing form of the Japanese mouse are derivatives of *Mus wagneri*, a native of Central Asia, and not of the common house mouse. In a cross with the latter, the characters of the waltzer tended to remain together in the F_2 generation.—A. J. H. Russell: A statistical approach to the epidemiology of cholera in Madras Presidency. The monthly mortality figures for the period 1902–21 are used, and the population dealt with numbers 43 millions. There is an annual and a six-yearly periodicity and a varying relationship in different areas with rainfall.—Harold Hotelling: The distribution of correlation ratios calculated from random data.—E. W. Stearn, B. F. Sturdivant, and A. E. Stearn: The life-history of a micro-parasite isolated from carcino-

matous growths. Cultures or extracts of carcinomatous tissue give an organism the life-history of which seems to include rods, thread-like forms with tapering ends, cocci of various sizes, and large sporing bodies. The optimum temperature is 37° – 41° C. In fluid from the tissue it is almost invisible and passes filters, but can be detected as a loosely coiled spirillum. In cultured colonies, under certain conditions, orthorhombic crystals appeared.

Official Publications Received.

- Sinai Yobō Tyōsaku Hōkoku (Reports of the Imperial Earthquake Investigation Committee.) No. 100, A. Pp. vi+854+60 plates+3 maps. No. 100, B. Pp. iv+126+44 plates+3 maps. No. 100, E. Pp. vii+297+31 plates+18 maps. (Tokyo.)
- Department of Commerce: Bureau of Standards. Miscellaneous Publications, Bureau of Standards, No. 61: History of the Standard Weights and Measures of the United States. By Louis A. Fischer. Pp. v+34. (Washington: Government Printing Office.) 16 cents.
- United States Department of Agriculture: Department Bulletin No. 1319: The Brood-Rearing Cycle of the Honeybee. By W. J. Nolan. Pp. 56. (Washington: Government Printing Office.) 10 cents.
- Report of the Aeronautical Research Institute, Tōkyō Imperial University. Vol. 1, No. 12: The Standard Atmosphere and the Corrections to be Applied to a Reading of an Altimeter. By Takurō Tamaru. Pp. 321-346. (Tokyo: Maruzen Kabushiki-Kaisha.) 50 yen.
- Congrès International des Aménageurs. Compte rendu de la XXI^e session, Deuxième partie, tenue à Göteborg en 1924. Pp. xxxix+706. (Göteborg: Museum.)
- United States Department of Agriculture. Department Bulletin No. 1359: Food of American Phalaropes, Avocets and Stilts. By Alexander Wetmore. Pp. 23+3 plates. (Washington: Government Printing Office.)
- The Development of India's Forest Resources. Compiled by the Economic Branch of the Forest Research Institute, Dehra Dun. Pp. v+39+22 plates. (Calcutta: Government of India Central Publication Branch.) 2.12 rupees; 5s.
- The National Institute of Agricultural Botany. Sixth Report and Accounts, 1924-25. Pp. 19. (Cambridge.)
- Department of the Interior: Bureau of Education. Bulletin, 1925, No. 11: Accredited Secondary Schools in the United States. Pp. v+119. (Washington: Government Printing Office.) 15 cents.
- Studies from the Connaught Laboratories, University of Toronto. Vol. 2, 1922-1925. Pp. 278. (Toronto: University of Toronto Press.)
- The Linnean Society of New South Wales. Historical Notes of its First Fifty Years (Jubilee Publication). Compiled by Dr. A. B. Walkom. Pp. 46. (Sydney, N.S.W.)
- Seale-Hayne Agricultural College, Newton Abbot, Devon. Pamphlet 17: The Cost of Food in Milk Production (Third Report). By D. R. Edwards-Ker and T. J. Shaw. Pp. 21. (Newton Abbot, Devon.)
- British Photographic Research Association. Report for the Year 1924-25. Pp. 10. (London.)
- Aeronautical Research Committee. Reports and Memoranda, No. 987 (Ae. 183): An Experimental Study of the Vibrations in the Blades and Shaft of an Airscrew. By A. Fage. (A.3.d. Airscrews, 78—T. 1947.) Pp. 16+1 plate. (London: H.M. Stationery Office.) 9d. net.
- British Cast Iron Research Association. Fourth Annual Report for the Year ending June 30th, 1925. Pp. 20. (Birmingham.)
- Ministry of Agriculture and Fisheries. Miscellaneous Publications, No. 49: Report on the Occurrence of Insect Pests on Crops in England and Wales for the Years 1922, 1923 and 1924. Pp. 86. (London: Ministry of Agriculture and Fisheries.) 1s. 6d. net.
- Ministry of Public Works, Egypt: Physical Department. Helwan Observatory, Bulletin No. 42: Corrections to Observed Times of Wireless Signals, 1922 November to 1924 June. By H. Knox-Shaw and P. A. Orry. Pp. 131-141. (Cairo: Government Publications Office.)
- Spisy vydávané Přírodovědeckou Fakultou Masarykovy University (Publications de la Faculté des Sciences de l'Université Masaryk). Rédigées par Bohuslav Hostinský. Čís. 52: Iter Turcico-Persicum. Pars 2: Plantarum collectarum enumeratio (Compositae). Scripsit Dr. Fr. Nábělek. Pp. 57+12 tab. Čís. 55: Nástin zeměpisného rozšíření lišejníků na Moravě vzhledem k poměrům evropským: srovnávací studie fytogeografická. (A Sketch of the Distribution of Lichens in Moravia with regard to the Conditions in Europe: a Phytogeographical Comparative Study.) Napsal Jindřich Suza. Pp. 162. Čís. 56: Onobrychis generis revisio critica. Pars prima. Scripsit G. Širjajev. Pp. 197+17 tab. Čís. 57: Studie o larvách Corixid I. (Études sur les larves des Corixides I.) Napsal V. Teyrovský. Pp. 13. Čís. 53: Parasitismus a metamorfóza druhu Gordius tolosanus Duj. (Parasitism and Metamorphosis of the species Gordius tolosanus Duj.) Napsal Jan Švábeník. Pp. 48+2 tab. Čís. 59: O růstových útvarcích vznikajících reakcemi na rozhraní mezi roztoky elektrolytů ve vodě a v gelu. (On the Growth of Structures formed by Reactions on the Boundary between Solutions of Electrolytes in Water and those in Gel.) Napsal Vladimír Morávek. Pp. 42+5 tab. Čís. 60: Příspěvek ke kvantitativnímu stanovení kyseliny mléčné: mikrometoda ke stanovení v krvi. (Recherches sur le dosage de l'acide lactique: le microdosage dans le sang.) Napsal J. Frejka a K. Všecká. Pp. 27. Čís. 61: Nový zjev elektrokinetický: Příspěvek ke studiu elektrokapilarity roztaveného kyslíčnicku tellurického. (Un nouveau phénomène électrocinétique: étude de l'électrocapillarité de l'oxide tellureux fondu.) Napsal A. Šimek a H. Kadlcová. Pp. 21+2 tab. Čís. 62: Rhamphorhynchus Gemmingeri, H. v. Meyer. Napsal Fr. Rikovsky. Pp. 14. Čís. 63: O absorpci plyného chlorovodíku v kyselině sírové. (The Absorption of Gaseous Hydrogen Chloride by Sulphuric Acid.) Napsal Václav Čupr. Pp. 13. (Brno.)

Diary of Societies.

MONDAY, DECEMBER 7.

- ROYAL SOCIETY OF EDINBURGH, at 4.30.—W. J. M. Menzies: Salmon (*Salmo salar*) of the River Moisie, Eastern Canada.—Fred. J. Symon: The Diffusion of Salt Vapours in a Bunsen Flame.—William Cooper: Note on Copper-tinted Flame Caps.—F. A. E. Crew: Prenatal Death in the Pig, and its Effect upon the Sex-Ratio.—E. L. Ince: Researches into the Characteristic Numbers of the Mathieu Equation.—T. M. MacRobert: The Addition Theorem for the Legendre Functions of the Second Kind.—Sir Thomas Muir: The Theory of Continuants from 1900 to 1920.
- VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—G. B. Michell: Scientific Criticism of the Bible.
- BIOCHEMICAL SOCIETY (in the Biochemical Laboratory, Imperial College of Science and Technology), at 5.—H. W. Buston and S. B. Schryver: The Isolation of some Further Undescribed Products of the Hydrolysis of Proteins.—H. Martin and S. B. Schryver: The Action of an Electric Field on Egg Albumin.—H. Chick: Sources of Error in the Biological Method of Investigating Fat-soluble Vitamins.—W. V. Thorpe: The Action of Enzymes on the Oxytocic Principle of the Pituitary.—R. K. Cannan: Potentiometric Studies in Biological Oxidation-Reductions.—D. T. Harris: The Action of Light on Blood.
- SOCIETY OF ENGINEERS (at the Geological Society), at 5.30.—H. E. I. Taylor: The Growth of the Gothic Church Window.
- BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (Annual General Meeting) (at London Day Training College), at 6.—Prof. T. P. Nunn: Some Notes of a Visit to American Educational Institutions.
- INSTITUTION OF STRUCTURAL ENGINEERS (Students' Meeting) (at Abbey House, 2 Victoria Street), at 6.—E. F. Michells and others: Discussion on How to pass Examinations.
- ROYAL INSTITUTION, at 7.—General Meeting.
- INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—C. L. Lipman and others: Discussion on Design and Performance of Protective Relays.
- INSTITUTION OF AUTOMOBILE ENGINEERS (Loughborough Graduates' Meeting) (at the College, Loughborough), at 7.
- NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Middlesbrough), at 7.30.—W. Goldsborough: Testing of Turbo-Blowers.
- OPTICAL SOCIETY (at Imperial College of Science), at 7.30.
- INSTITUTION OF STRUCTURAL ENGINEERS (Midland Counties Branch) (at Birmingham), at 7.30.
- ARISTOTELIAN SOCIETY (at University of London Club), at 8.—C. R. Morris: Judgment as the Fundamental Act of Knowledge.
- ROYAL SOCIETY OF ARTS, at 8.—Dr. R. Lessing: Coal Ash and Clean Coal (Cantor Lectures, III.).
- SURVEYORS' INSTITUTION, at 8.—Col. C. H. Bressley: Modern Methods of Roadmaking.
- ROYAL GEOGRAPHICAL SOCIETY (at Aeolian Hall), at 8.30.—Prof. L. W. Collet: The Lakes of Scotland and of Switzerland.
- BIOCHEMICAL SOCIETY (at Imperial College of Science).
- SOCIETY OF CHEMICAL INDUSTRY (London Section) (Joint Meeting with the Institute of Chemistry, London and South-Eastern Counties Section) (at Institution of Mechanical Engineers), at 8.—W. J. U. Woolcock: Five Years of Progress in the Fine Chemical Industry.

TUESDAY, DECEMBER 8.

- MANCHESTER GEOLOGICAL AND MINING SOCIETY, at 4.
- INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—J. H. S. Dickenson, B. Gray, and F. E. Cherry: The Selection and Properties of Steels used for Oil Well Boring Equipment.
- INSTITUTE OF MARINE ENGINEERS, at 6.30.—M. L'Hermier: Powdered Fuel Developments.
- INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at the College, Loughborough), at 6.45.—F. J. Mollatt: Address.
- INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Prof. S. P. Smith: An All-Electric House.
- ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—T. Thorne Baker and F. L. Davidson: A New Physical Method for the Examination of Gelatine.—E. L. Turner and C. D. Hallam: The Basis of the Image in Photo-Lithography.—F. J. Tritton: On the Theory of the Carbro Process.
- INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—Major E. I. David: Electricity in Mines.
- INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Cafe, Coventry), at 7.30.—General Meeting.
- PHARMACEUTICAL SOCIETY, at 8.—Dr. A. W. Crossley: Cotton (Lantern Lecture).
- ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 8.15.—Capt. A. M. Hocutt: The Buddha's Illumination.
- INSTITUTION OF MECHANICAL ENGINEERS (Swansea Branch) (at Swansea).—

WEDNESDAY, DECEMBER 9.

- ROYAL SOCIETY OF ARTS (Indian and Dominions and Colonies Sections), at 4.30.—Dr. H. M. Leake: The Imperial College of Tropical Agriculture.
- RADIO SOCIETY OF GREAT BRITAIN (at the Institution of Electrical Engineers), at 6.—A. B. Bawtree: The Acoustics of the Headphone and Loud-Speaker.
- NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bobbe Hall, Newcastle-upon-Tyne), at 7.—T. B. Davison: Modern Transport.
- INSTITUTION OF ENGINEERS-IN-CHARGE (at St. Bride's Institute, Bride Lane), at 7.30.—J. V. Stevens: Oil Fuel for Commercial Purposes.
- INSTITUTION OF CHEMICAL ENGINEERS (at the Chemical Society, Burlington House).—Col. B. I. Rolling: Magnetic Separation.

INSTITUTION OF MECHANICAL ENGINEERS (Sheffield Branch) (at Sheffield).—H. F. L. Orcutt: Characteristics and Uses of Ground Gears.

THURSDAY, DECEMBER 10.

- LONDON MATHEMATICAL SOCIETY, at 5.—H. Levy: The Analysis of an Empiric Function into its Quasi-Periodic Constituents.—J. C. Burkill: The Expressions in Stieltje's Integrals of the Inversion Formulae of Fourier and Hankel.—W. L. Ferrar: (1) On the Summability (C, k) of Series of the Type $\sum a_n n^k$; (2) Necessary and Sufficient Conditions for Summability (C, r).—T. Stuart: (1) Fermat's Last Theorem: Arguments against a Solution; (2) The Diophantine Equation $X^4 + Y^4 + Z^4 = A W^4$ where $A = 1$ or 3 .—G. H. Hardy and J. E. Littlewood: Two Theorems concerning Fourier Series.—T. Vijayaraghavan: A Tauberian Theorem.
- CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. R. Langdon-Down: The Teaching of Shorthand as Part of a General Education.
- INSTITUTION OF STRUCTURAL ENGINEERS (Yorkshire Branch) (at Great Northern Hotel, Leeds), at 6.30.—E. F. Sargeant: Concrete Granary at Hull.
- INSTITUTE OF METALS (London Local Section) (Joint Meeting with the Institution of British Foundrymen) (in the Rooms of the Institute of Marine Engineers), at 7.30.—J. B. Hoblyn: Commercial Aluminium Alloys from the Users' Point of View.
- SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.—S. H. Piper: The Use of X-rays in Chemistry.
- INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (Jointly with Society of Chemical Industry, Edinburgh and East of Scotland Section) (at North British Station Hotel, Edinburgh), at 7.30.—R. B. Pilcher: Alchemists and Chemists in Art and Literature.
- INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—J. K. Murray: Some Features of Telegraph Engineering.
- OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—Col. H. S. Winterbotham, Lt.-Col. M. N. MacLeod, and Lt. M. Hotine: Photogrammetric Surveying.
- INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre) (at Trinity College, Dublin), at 7.45.—J. Lindsay: The Mechanical Winning of Peat (Lecture).
- SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, Strand), at 8.—Mme. A. Rieder: Population Problems in the Near East.
- OIL AND COLOUR CHEMISTS' ASSOCIATION.

FRIDAY, DECEMBER 11.

- ROYAL ASTRONOMICAL SOCIETY, at 5.—O. Struve: A Study of the Nature of Spectroscopic Binaries.—A. S. Williams: A New Variable Star in Andromeda.
- PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. E. A. Owen and G. D. Preston: On the Effect of Rolling on the Crystal Structure of Aluminium.—R. S. Burdon: The Spreading of One Liquid on the Surface of Another.—J. T. Combridge: On the Advance of the Perihelion of Mercury.
- MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.
- INSTITUTION OF MECHANICAL ENGINEERS, at 6.
- INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—F. J. Lane: The Rotary Converter Automatic Sub-Station.
- SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—Open Night.
- INSTITUTE OF METALS (Swansea Local Section) (in the Metallurgical Department, University College, Singleton Park), at 7.15.—Prof. J. H. Andrew: Modern Metallurgy.
- INSTITUTE OF METALS (Sheffield Local Section) (in the Non-Ferrous Section of the Applied Science Department of the University, St. George's Square), at 7.30.—Prof. F. C. Thompson: Nickel Silver.
- JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7.30.—J. S. Highfield: Presidential Address.
- INSTITUTION OF MECHANICAL ENGINEERS (Yorkshire Branch) (at Leeds).—Prof. G. F. Charnock: Chairman's Address.

SATURDAY, DECEMBER 12.

- BRITISH PSYCHOLOGICAL SOCIETY (at University College, London), at 3.—J. J. Strassheim: A New Method in Mental Testing.—Miss A. M. Jenkin: Eidetic Imagery.
- MINING INSTITUTE OF SCOTLAND (at Glasgow).
- PHYSIOLOGICAL SOCIETY (at Bedford College for Women).

PUBLIC LECTURES.

SATURDAY, DECEMBER 5.

- HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Travel and Transport in Ancient Egypt.

MONDAY, DECEMBER 7.

- SCHOOL OF ORIENTAL STUDIES, at 5.30.—(In French) J. Hackin: Les Monuments bouddhiques et les antiquités musulmanes de l'Afghanistan. (Succeeding Lectures on December 8 and 9.)
- UNIVERSITY OF LEEDS, at 8.—Sir Henry Hadow: Chamber Music, illustrated from Beethoven and Modern Composers.

THURSDAY, DECEMBER 10.

- KING'S COLLEGE, LONDON, at 5.15.—A. D. Lindsay: Benedict Spinoza.

SATURDAY, DECEMBER 12.

- HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. G. Cannon: Floating Life in the Sea.

Supplement to NATURE

No. 2927

DECEMBER 5, 1925

Atomic Theory and Mechanics.¹

By Prof. N. BOHR, University of Copenhagen.

THE CLASSICAL THEORIES:

THE analysis of the equilibrium and the motion of bodies not only forms the foundation of physics, but for mathematical reasoning has also furnished a rich field, which has been exceedingly fertile for the development of the methods of pure mathematics. This connexion between mechanics and mathematics showed itself at an early date in the works of Archimedes, Galileo, and Newton. In their hands the formation of concepts suitable for the analysis of mechanical phenomena was provisionally completed. Since the time of Newton, the development of the methods for treating mechanical problems has gone hand in hand with the evolution of mathematical analysis; we need only recall such names as Euler, Lagrange, and Laplace. The later development of mechanics too, based on the work of Hamilton, proceeded in very close association with the evolution of mathematical methods, the calculus of variations, and the theory of invariants, as appears clearly in recent times also in the papers of Poincaré.

Perhaps the greatest successes of mechanics lie in the domain of astronomy, but in the mechanical theory of heat an interesting application was also found in the course of the last century. The kinetic theory of gases, founded by Clausius and Maxwell, interprets the properties of gases to a large extent as results of the mechanical interactions of atoms and molecules flying about at random. We wish to recall especially the explanation of the two principles of thermodynamics given by this theory. The first principle is a direct result of the mechanical law of conservation of energy, while the second principle, the entropy law, can, following Boltzmann, be derived from the statistical behaviour of a large number of mechanical systems. It is of interest here that statistical considerations have permitted the description not only of the average behaviour of atoms, but also of the fluctuation phenomena, which have led by the investigation of the Brownian motion to the unexpected possibility of

counting atoms. The proper tools for the systematic development of statistical mechanics, to which especially Gibbs contributed, were furnished by the mathematical theory of canonical systems of differential equations.

The development of the electromagnetic theories in the second half of last century, following the discoveries of Oersted and Faraday, brought about a profound generalisation of mechanical concepts. Although, to begin with, mechanical models played an essential part in Maxwell's electrodynamics, the advantages were soon realised of conversely deriving the mechanical concepts from the theory of the electromagnetic field. In this theory the conservation laws are explained by considering energy and momentum to be localised in the space surrounding the bodies. In particular, a natural explanation of radiation phenomena can be obtained in this way. The theory of the electromagnetic field was the direct cause of the discovery of electromagnetic waves, which to-day play so important a part in electrical engineering. Further, the electromagnetic theory of light founded by Maxwell provided a rational basis for the wave theory of light, which goes back to Huygens. With the aid of the atomic theory it afforded a general description of the origin of light and the phenomena taking place during the passage of light through matter. For this purpose, the atoms are supposed to be built up of electrical particles which can execute vibrations about positions of equilibrium. The free oscillations of the particles are the cause of the radiation, the composition of which we observe in the atomic spectra of the elements. Further, the particles will execute forced vibrations under the forces in the light waves and thus become centres of secondary wavelets which will interfere with the primary waves and produce the well-known phenomena of reflection and refraction of light. When the frequency of vibration of the incident waves approaches the frequency of one of the free oscillations of the atom, there results a resonance effect, by which the particles are thrown into specially strong forced vibrations. In this way a natural account was obtained of the phenomena of resonance radiation and the anomalous dispersion of a substance for light near one of its spectral lines.

¹ This article represents substantially the contents of an address delivered, on August 30, before the sixth Scandinavian Mathematical Congress in Copenhagen. It should be mentioned, however, that the present elaboration of the text has been notably influenced by the appearance, since the delivery of the address, of an important paper by Heisenberg, to which reference is made below.

Just as in the kinetic theory of gases, it is not merely the average effect of a large number of atoms that comes into consideration in the electromagnetic interpretation of optical phenomena. Thus, in the scattering of light the random distribution of the atoms makes the effects of the individual atoms appear in such a way that a direct counting of the atoms is possible. In fact, Rayleigh estimated from the intensity of the scattered blue light of the sky the number of atoms in the atmosphere, obtaining results in satisfactory agreement with the counting of atoms obtained by Perrin from a study of the Brownian motion. The rational mathematical representation of the electromagnetic theory is based on the application of vector analysis, or more generally tensor analysis of higher dimensional manifolds. This analysis founded by Riemann offered the proper means for the formulation of Einstein's fundamental theory of relativity, which introduces concepts that go beyond Galileo's kinematics, and may perhaps be considered as the natural completion of the classical theories.

THE QUANTUM THEORY.

In spite of all the successful applications of mechanical and electrodynamical ideas to atomic theory, further development revealed profound difficulties. If these theories really provide a general description of thermal agitation and of the radiation connected with motion, then the general laws of heat radiation must be capable of a direct explanation. Contrary to all expectations, however, a calculation on this basis could not explain the empirical laws. Going beyond this, Planck demonstrated, retaining Boltzmann's account of the second law of thermodynamics, that the laws of heat-radiation demand an element of discontinuity in the description of atomic processes quite foreign to the classical theories. Planck discovered that in the statistical behaviour of particles which execute simple harmonic oscillations about positions of equilibrium, only such states of vibrations must be taken into account the energy of which is an integral multiple of a "quantum," ωh , where ω is the frequency of the particle and h a universal constant, the so-called Planck's quantum of action.

The more precise formulation of the content of the quantum theory appears, however, to be extremely difficult when it is remembered that all the concepts of previous theories rest on pictures which demand the possibility of a continuous variation. This difficulty was especially emphasised by the fundamental researches of Einstein, according to which essential features of the interaction between light and matter suggest that the propagation of light does not take place by spreading waves but by "light-quanta,"

which, concentrated in a small region of space, contain the energy $h\nu$, where ν is the frequency of the light. The formal nature of this statement is evident, because the definition and measurement of this frequency rests exclusively on the ideas of the wave theory.

STRUCTURAL UNITS OF THE ATOM.

This inadequacy of the classical theories was brought into prominence by the development of our knowledge of atomic structure. One formerly hoped that this knowledge might be gradually enlarged by an analysis of the properties of the elements based on the classical theories, which had been fruitful in so many respects. This hope was supported shortly before the birth of the quantum theory by Zeeman's discovery of the effect of magnetic fields on spectral lines. As Lorentz showed, this effect corresponds in many cases to just that action of magnetic fields on the motion of oscillating particles which is to be expected from classical electrodynamics. Besides, this account allowed conclusions to be drawn about the nature of the oscillating particles which agreed beautifully with the experimental discoveries of Lenard and Thomson in the field of electric discharges in gases. As a result, small negatively charged particles, the electrons, were recognised as units common to all atoms. It is true that the so-called "anomalous" Zeeman effect of many spectral lines caused profound difficulties for the classical theory. These were similar to those which showed themselves in the attempts with the aid of electrodynamic models to explain the simple empirical regularities among the spectral frequencies, which were brought to light through the work of Balmer, Rydberg, and Ritz. In particular, such an account of the spectral laws could scarcely be reconciled with the estimate of the number of electrons in the atom which Thomson obtained from observations on the scattering of X-rays by a direct application of the classical theory.

These difficulties could for a time be attributed to our imperfect knowledge of the origin of the forces by which the electrons are bound in the atom. The situation was, however, entirely changed by the experimental discoveries in the field of radio-activity, which furnished new means for the investigation of atomic structure. Thus, Rutherford obtained convincing support for the idea of the nuclear atom from experiments on the passage through matter of the particles ejected by radio-active substances. According to this idea, the greatest part of the atomic mass is localised in a positively charged nucleus, exceedingly small compared with the dimensions of the atom as a whole. Around the nucleus there move a number of light negative electrons. In this way, the problem of atomic structure took on a great similarity to the

problems of celestial mechanics. A closer consideration, however, soon showed that, nevertheless, there exists a fundamental difference between an atom and a planetary system. The atom must have a stability which presents features quite foreign to mechanical theory. Thus, the mechanical laws permit a continuous variation of the possible motions, which is entirely at variance with the definiteness of the properties of the elements. The difference between an atom and an electrodynamic model appears also when one considers the composition of the emitted radiation. For, in models of the sort considered, where the natural frequencies of motion vary continuously with the energy, the frequency of the radiation will change continuously during emission according to classical theory and will therefore show no similarity to the line spectra of the elements.

QUANTUM THEORY OF ATOMS.

The search for a more precise formulation of the concepts of the quantum theory which might be capable of overcoming these difficulties led to the enunciation of the following postulates:

1. An atomic system possesses a certain manifold of states, the "stationary states," to which corresponds in general a discrete sequence of energy values and which have a peculiar stability. This latter shows itself in that every change in the energy of the atom must be due to a "transition" of the atom from one stationary state to another.

2. The possibility of emission and absorption of radiation by the atom is conditioned by the possibility of energy changes of the atom, in such a way that the frequency of the radiation is connected with the energy difference between the initial and final states by the formal relation

$$h\nu = E_1 - E_2.$$

These postulates, which cannot be explained on classical ideas, seem to offer a suitable basis for the general account of the observed physical and chemical properties of the elements. In particular, an immediate explanation is given of a fundamental feature of the empirical spectral laws. This feature, the Ritz principle of combination of spectral lines, states that the frequency of every line in a spectrum can be represented as the difference between two terms of a manifold of spectral terms characteristic of the element; in fact, we see that these terms can be identified with the energy values of the stationary states of the atom, divided by h . In addition, this account of the origin of spectra gives an immediate explanation of the fundamental difference between absorption and emission spectra. For, according to the postulates, the condition for selective absorption of a frequency which corre-

sponds to the combination of two terms is that the atom is in the state of smaller energy, while for emission of such radiation, it must be in the state of greater energy. In short, the picture described is in very close agreement with the experimental results on the excitation of spectra. This is shown especially in the discovery of Franck and Hertz as to impacts between free electrons and atoms. They found that an energy transfer from the electron to the atom can take place only in amounts which are just the energy differences of the stationary states as computed from the spectral terms. In general, the atom is simultaneously excited to emit. Similarly, the excited atom can, according to Klein and Rosseland, lose its emissive power through an impact, and the colliding electron experiences a corresponding increase of its energy.

As Einstein has shown, the postulates also furnish a suitable basis for a rational treatment of statistical problems, especially for a very lucid derivation of Planck's law of radiation. This theory assumes that an atom, which can undergo a transition between two stationary states and is in the higher state, shows a certain "probability," depending only on the atom, of jumping spontaneously to the lower state in a given interval of time. Further, it assumes that external illumination with radiation of the frequency corresponding to the transition gives the atom a probability, proportional to the intensity of the radiation, of going from the lower to the higher state. It is also an essential feature of the theory that illumination with this frequency gives the atom in the higher state, besides its spontaneous probability, an induced probability of jumping down to the lower state.

QUANTUM THEORY OF RADIATION.

While Einstein's theory of heat radiation gives support to the postulates, it accentuates the formal nature of the frequency condition. For from the conditions for complete thermal equilibrium, Einstein draws the conclusion that every absorption and emission process is accompanied by a transfer of momentum of amount $h\nu/c$, where c is the velocity of light, just as the idea of light quanta would lead one to expect. The significance of this conclusion has been emphasised in a very interesting way by the discovery of Compton that the scattering of homogeneous X-rays is accompanied by a change of wave-length in the scattered radiation depending on the direction of observation. Such a change in frequency follows in a simple way from the light-quantum theory if in the deflexion of the quantum one takes into account the conservation of momentum as well as energy.

The constantly growing contrast between the wave theory of light, apparently required for the explanation

of optical phenomena, and the light-quantum theory, which represents naturally so many features of the interaction between light and matter, suggested that the failure of classical theories may even affect the validity of the laws of conservation of energy and momentum. These laws, which hold so central a position in the classical theory, would, then, in the description of atomic processes, be only statistically valid. However, this suggestion does not offer a satisfactory escape from the dilemma, as is shown by the experiments on the scattering of X-rays which have been undertaken recently with the beautiful methods permitting a direct observation of individual processes. For Geiger and Bothe have been able to show that the recoil electrons and photo-electrons which accompany the production and absorption of the scattered radiation are coupled in pairs just as one would expect from the picture of the light-quantum theory. With the method of the Wilson cloud chamber, Compton and Simon have even succeeded in demonstrating, besides this pairing, the connexion demanded by the light-quantum theory between the direction in which the effect of the scattered radiation is observed and the direction of the velocity of the recoil electrons accompanying the scattering.

From these results it seems to follow that, in the general problem of the quantum theory, one is faced not with a modification of the mechanical and electro-dynamical theories describable in terms of the usual physical concepts, but with an essential failure of the pictures in space and time on which the description of natural phenomena has hitherto been based. This failure appears also in a closer consideration of impact phenomena. In particular, for impacts in which the time of collision is short compared to the natural periods of the atom and for which very simple results are to be expected according to the usual mechanical ideas, the postulate of stationary states would seem to be irreconcilable with any description of the collision in space and time based on the accepted ideas of atomic structure.²

THE CORRESPONDENCE PRINCIPLE.

Nevertheless, it has been possible to construct mechanical pictures of the stationary states which rest on the concept of the nuclear atom and have been essential in interpreting the specific properties of the elements. In the simplest case of an atom with only one electron, such as the neutral hydrogen atom, the orbit of the electron would be in classical mechanics a closed ellipse, obeying Kepler's laws, according to which the major axis and frequency of revolution are

connected in a simple way with the work necessary for a complete separation of the atomic particles. Now if we regard the spectral terms of the hydrogen spectrum as determining this work, we see in that spectrum evidence of the steplike process through which the electron under emission of radiation is gradually bound more and more firmly in states visualised as orbits of smaller and smaller dimensions. When the electron is bound as firmly as possible, and the atom can therefore emit no further radiation, the normal state of the atom has been reached. The orbital dimensions estimated from the spectral terms have values for this state of the same order of magnitude as the atomic dimensions obtained from the mechanical properties of the elements. From the nature of the postulates, however, such features of the mechanical pictures as frequency of revolution and shape of the electronic orbits are not open to comparison with observations. The symbolic character of these pictures can scarcely be more strongly emphasised than by the fact that in the normal state no radiation is emitted, although according to the mechanical picture the electron is still moving.

Nevertheless, the visualisation of the stationary states by mechanical pictures has brought to light a far-reaching analogy between the quantum theory and the mechanical theory. This analogy was traced by investigating the conditions in the initial stages of the binding process described, where the motions corresponding to successive stationary states differ comparatively little from each other. Here it was possible to demonstrate an asymptotic agreement between spectrum and motion. This agreement establishes a quantitative relation by which the constant appearing in Balmer's formula for the hydrogen spectrum is expressed in terms of Planck's constant and the values of the charge and mass of the electron. The essential validity of this relation was clearly illustrated by the subsequent test of the predictions of the theory regarding the dependence of the spectrum on the nuclear charge. The latter result may be considered as the first step towards the fulfilment of the programme presented by the concept of the nuclear atom, to account for the relationships between the properties of the elements solely by means of the integer which represents the number of unit charges on the nucleus, the so-called "atomic number."

The demonstration of the asymptotic agreement between spectrum and motion gave rise to the formulation of the "correspondence principle," according to which the possibility of every transition process connected with emission of radiation is conditioned by the presence of a corresponding harmonic component in the motion of the atom. Not only do the frequencies of the corresponding harmonic components agree

² For a closer discussion of these problems reference may be made to a recent article of the writer; compare in particular the addendum (*Zs. für Phys.* 34, 142, 1925).

asymptotically with the values obtained from the frequency condition in the limit where the energies of the stationary states converge, but also the amplitudes of the mechanical oscillatory components give in this limit an asymptotic measure for the probabilities of the transition processes on which the intensities of the observable spectral lines depend. The correspondence principle expresses the tendency to utilise in the systematic development of the quantum theory every feature of the classical theories in a rational transcription appropriate to the fundamental contrast between the postulates and the classical theories.

THE RULES OF QUANTISATION.

The development was considerably furthered by the fact that it seemed possible to formulate certain general laws, the so-called rules of "quantisation," by means of which the mechanical motions associated with the stationary states were to be chosen from the continuous manifold of such motions. These rules concern atomic systems for which the solution of the mechanical equations of motion is simply- or multiply-periodic. In these cases the motion of every particle can be represented as a superposition of discrete harmonic vibrations. According to the rules of quantisation which were considered to be a rational generalisation of Planck's original result for the possible energy values of an harmonic oscillator, certain components of action which characterise the solution of the mechanical equations of motion are put equal to integral multiples of Planck's constant. By means of these rules a classification of the stationary states results in which a set of integers, the "quantum indices," is ascribed to every state. Their number is equal to the degree of periodicity of the mechanical motion.

In formulating the rules of quantisation the modern development of the mathematical methods of dealing with mechanical problems was of decisive importance. We need recall only the theory of phase integrals utilised in particular by Sommerfeld, as well as the property of adiabatic invariance of these integrals emphasised by Ehrenfest. The theory was given a very elegant form by the introduction of the uniformising variables of Stäckel. In this form the fundamental frequencies determining the periodicity properties of the mechanical solution appear as the partial derivatives of the energy with respect to the components of action to be quantised. The asymptotic connexion between the motion and the spectrum as calculated from the frequency condition is secured in this way.

With the help of the rules of quantisation, many finer details of spectra seemed to be accounted for naturally. Of especial interest was Sommerfeld's demonstration, that the small deviations from a Keplerian motion,

which result from the modification of Newtonian mechanics demanded by the relativity theory, offer an explanation of the fine-structure of the hydrogen lines. Furthermore, we would recall here the explanation given by Epstein and Schwarzschild of the splitting up of the hydrogen lines in an external electric field which Stark discovered. We are here dealing with a mechanical problem, the treatment of which was much improved in the hands of mathematicians like Euler and Lagrange, until Jacobi stated his famous elegant solution by means of Hamilton's partial differential equation. Especially after the utilisation of the correspondence principle—by which not only the polarisation of the Stark effect components was interpreted, but also, as Kramers showed, the peculiar intensity distribution of these components—can we say that in this effect every trait of Jacobi's solution can be recognised, although hidden under a quantum theory mask. In this connexion it is of interest to mention that with the help of the correspondence principle, the effect of a magnetic field on the hydrogen atom could be treated so as to show a far-reaching similarity with Lorentz's account of the Zeeman effect on the basis of classical electrodynamics, especially in the form given by Larmor.

STABILITY OF ATOMIC STRUCTURE.

While the last-mentioned problems represent direct applications of the rules of quantisation, we meet, in the problem of the structure of atoms with several electrons, a case where the general solution of the mechanical problem does not possess the periodic properties which seem to be necessary for the mechanical picturing of the stationary states. It suggested itself, however, that this further limitation of the applicability of mechanical pictures in the study of the properties of atoms with several electrons, beyond that in the study of atoms containing only one electron, is directly connected with the postulate of the stability of stationary states. In fact, the interaction of the electrons in the atom presents a problem which is quite analogous to the problem of a collision between an atom and a free electron. Just as no mechanical explanation can be given for the stability of an atom in the collision, so we must suppose that already, in the description of the stationary states of the atom, the special part which every electron plays in its interaction with the other electrons is secured in an entirely unmechanical way.

This view is in general conformity with the spectroscopic evidence. An important feature of this evidence is the discovery of Rydberg, that in spite of the more complicated structure of the spectra of other elements compared to that of hydrogen, the same constant as that in the Balmer formula appears in the empirical formulæ of the series spectra of all elements. This discovery is simply explained by regarding the series spectra as evidence of processes by which an electron is added to an atom, its binding becoming more firm step by step with the emission of radiation. While the character of the binding of the other electrons remains the same, the steplike strengthening of the binding of this electron is visualised by orbits which at first are large compared with usual atomic dimensions, and become smaller and smaller until the normal state

of the atom is reached. In the case when the atom has a single positive charge before the capture of the electron, the attraction of the electron by the rest of the atom will, on this picture of the binding process, at first coincide closely with the attraction of the particles in the hydrogen atom. It is therefore clear why the spectral terms representing the binding of the electrons show an asymptotic convergence to the terms of the hydrogen spectrum. In the same way one obtains a direct explanation of the general dependence of a series spectrum on the state of ionisation of the atom, brought to light so beautifully through the work of Fowler and Paschen.

Typical evidence of the way in which the electrons are bound in the atoms is also afforded by the study of the X-ray spectra. On one hand, the fundamental discovery of Moseley, of the striking similarity of the X-ray spectrum of an element to the spectrum that corresponds to the binding of a single electron by the nucleus, can be easily understood if it is remembered that in the interior of the atom the direct influence of the nucleus on the nature of the binding of each individual electron exceeds greatly the mutual influence of the electrons. On the other hand, the X-ray spectra show certain characteristic differences from the series spectra. These originate from the circumstance that in the former we do not witness the binding of an additional electron in the atom, but the reorganisation of the binding of the remaining electrons upon removal of one of the electrons previously bound. This circumstance, which has been especially emphasised by Kossel, was well suited for bringing to light new and important features of the stability of atomic structure.

THE ANALYSIS OF SPECTRA.

To account for the details of the spectra, a closer study of the interplay of the electrons in the atom is, of course, required. Disregarding a strict application of mechanics, an attack was made on this problem by assigning to every electron a motion of such periodic properties that a classification of the spectral terms by means of quantum indices could be accomplished. In the hands of Sommerfeld, in particular, a number of regularities of spectra were simply explained in this way. Further, these considerations afforded a fruitful field of application for the correspondence principle. In fact, this gave an account of the peculiar limitations in the possibilities of combining spectral terms, the so-called selection rules for spectral lines.

On these lines, it has recently been possible by making use of the evidence from series spectra, as well as from X-ray spectra, to draw conclusions about the grouping of electrons in the normal state of the atom. This grouping explained the general features of the periodic system of the elements in conformity with the ideas of chemical activity of atoms as developed especially by J. J. Thomson, Kossel, and G. N. Lewis. Progress in this field has been intimately connected with the great enrichment during the last few years of spectroscopic evidence, and, not least, by the investigations of Lyman and Millikan, the gap has been almost bridged over between the optical spectra and the region of X-rays, where great advances have been

made in recent years by Siegbahn and his collaborators. In this connexion the work of Coster on the X-ray spectra of heavy elements may be mentioned as affording beautiful support for the account of essential features of the periodic system.

The analysis of the finer details of the spectra, however, has brought to light a number of features which could not be interpreted with mechanical pictures on the basis of the theory of periodicity systems. We refer in particular to the multiplet structure of spectral lines and the effect of magnetic fields on these structures. These latter phenomena, which are generally known as anomalous Zeeman effects and, as mentioned above, had already led to difficulties in the classical theories, fitted, it is true, in a natural way into the scheme of the fundamental postulates of the quantum theory. For, as Landé showed, the frequencies of the components into which each spectral line is split up by the field can, like the original lines, be represented as combinations of terms. The manifold of these magnetic terms is obtained by replacing each original spectral term by a set of values which differ from it by small quantities depending on the field intensity. In fact, the beautiful experiments of Stern and Gerlach, by which a direct connexion was established between the force which acts on an atom in a non-homogeneous magnetic field and the energy values of the stationary states in the field calculated from the magnetic terms, may be regarded as a most direct support of the fundamental ideas of the quantum theory.

Landé's analysis discloses, however, a strange difference between the interactions of the electrons in the atom and the coupling of mechanical systems. In fact, we are forced to assume the presence of a mechanically undescrivable "strain" in the interaction of the electrons which prevents a unique assignment of quantum indices on the basis of mechanical pictures.³ In the discussion of this problem a general condition of thermodynamic stability introduced by Ehrenfest played an important part. When applied to the postulates of the quantum theory, this condition states that the statistical weight attributed to a stationary state is a quantity which cannot be changed by a continuous transformation of the atomic system. Moreover, it has recently been recognised that this same condition leads, even for atoms with only one electron, to difficulties which point to a limitation of the validity of the theory of periodicity systems. In fact, the problem of the motion of point charges admits of certain singular solutions which must be excluded from the manifold of stationary states. This exclusion artificially restricts the rules of quantisation, but at first this restriction did not obviously contradict experimental evidence. Difficulties of an especially grave nature, however, were brought to light by the interesting analysis by Klein⁴ and Lenz⁵ of the problem of a hydrogen atom in crossed electric and magnetic fields. Here it was found impossible to satisfy Ehrenfest's condition, since suitable variation of the external

³ Compare an article of the writer (*Ann. d. Phys.* 71, 228, 1923) which contains a general survey of the results regarding the explanation of spectral evidence on the basis of mechanical pictures of stationary states. In this article detailed reference to the earlier literature on the subject may be found, and we therefore have confined ourselves here to quoting papers which have appeared since then.

⁴ O. Klein, *Zs. für Phys.* 22, 109, 1924.

⁵ W. Lenz, *Zs. für Phys.* 24, 197, 1924.

forces would gradually transform orbits depicting stationary states which could not always be excluded from the manifold of these states, into orbits where the electron falls into the nucleus.

Apart from these difficulties, the analysis of the finer details of the spectra has considerably furthered the quantum theory interpretation of the laws of the relationship between the elements. In fact, an extension of the ideas regarding the grouping of the electrons to which the quantum theory has led has recently been suggested by Dauvillier,⁶ Main Smith,⁷ and Stoner,⁸ taking various kinds of evidence into consideration. Notwithstanding the formal nature of these suggestions, they exhibit a close connexion with the spectral regularities disclosed by Landé's analysis. In this direction important progress has recently been made, especially by Pauli.⁹ Notwithstanding that the results thus obtained constitute an important step towards the above-mentioned programme of accounting for the properties of the elements solely on the basis of the atomic number, it must be remembered, however, that the results do not allow of a unique association with mechanical pictures.

QUANTUM THEORY AND OPTICAL PHENOMENA.

A new era in the development of the quantum theory has been opened up during the last few years by a closer study of optical phenomena. While, as mentioned above, the classical theory had such great successes in this field, the postulates at first gave no direct clue. From experiment, it is true, one could conclude that an atom, when illuminated, caused a scattering of the light essentially analogous to the classically computed scattering of elastically bound electrical particles, the natural frequencies of which are the same as the frequencies corresponding to the transition processes which the atom can perform under the influence of external radiation. In fact, on the classical theory such harmonic oscillators would, when excited, emit a radiation of just the same constitution as that of atoms transferred to a higher stationary state.

The possibility of obtaining a unified description of optical phenomena with this concept of oscillators conjugated to the transitions was essentially advanced by an idea of Slater,¹⁰ according to which the emission of radiation from an activated atom may be regarded as "cause" for the spontaneous transitions, in analogy to the effect of incident radiation in producing transitions. Ladenburg made a first important step towards a quantitative description of dispersion by suggesting a definite connexion between the scattering activity of the oscillators and the probabilities of the corresponding transitions in Einstein's theory. Decisive progress, however, was made by Kramers¹¹ by an ingenious transcription in harmony with the correspondence principle of the effects which, according to classical theory, are brought about in an electro-

dynamical system by illumination with light waves. Just as the radiation frequencies are calculated in the classical theory, on one hand, and the quantum theory on the other hand,⁶ it is typical in this transcription, that differential quotients are replaced by differences, in such a way that in the final formulæ only quantities open to direct observation appear. Thus in Kramers' theory the scattering of an atom in a certain stationary state is quantitatively connected with the frequencies corresponding to the different transition processes to other stationary states as well as to the probabilities of the appearance of these transitions under the influence of illumination.

It is an essential feature of the theory that in calculating the anomalous dispersion near a spectral line, one has to take into account two opposite kinds of resonance effects depending on whether the spectral line corresponds to a transition of the atom to a state of larger or smaller energy. Only the first of these corresponds with the resonance effects which have been utilised previously in accounting for dispersion on the basis of the classical theory. It is also very interesting that the further development of the theory by Kramers and Heisenberg¹² gave a natural quantitative description of additional scattering effects with changed frequencies, the existence of which had been predicted by Smekal¹³ from considerations based on the theory of light quanta, which thereby again has shown its fertility.

While this description of optical phenomena was entirely in harmony with the fundamental ideas of the quantum theory, it soon appeared that it stood in strange contradiction to the use of the mechanical pictures previously employed for an analysis of the stationary states. In the first place, it is impossible on the basis of the scattering activity of illuminated atoms demanded by the dispersion theory to construct an asymptotic connexion between the reaction of an atom in alternating fields of smaller and smaller frequency and the reaction in constant fields as calculated from quantisation rules of the theory of periodicity systems. This difficulty strengthened the doubts about this theory to which, as already mentioned, the problem of the hydrogen atom in crossed electric and magnetic fields had led. Secondly, it had to be regarded as especially unsatisfactory that the theory of periodicity systems was apparently helpless in the problem of the quantitative determination of the transition probabilities on the basis of the mechanical pictures of stationary states. This was felt all the more, as it was possible in several cases to obtain a quantitative formulation of the general statements of the correspondence principle as regards these transition probabilities with the help of viewpoints suggested by an analysis of the optical behaviour of electrodynamic models.¹⁴ These results stood in excellent agreement with measurements on the relative intensities of spectral lines, as they have been developed especially in Utrecht

⁶ A. Dauvillier, *C.R. Acad. Sci.*, 177, 476, 1924.

⁷ J. D. Main Smith, *Journ. Chem. Ind.*, 44, 944, 1925.

⁸ E. C. Stoner, *Phil. Mag.*, 48, 719, 1924.

⁹ W. Pauli, Jr., *Zs. für Phys.* 31, 765, 1925. Compare also H. N. Russell and F. A. Saunders, *Astrophys. Journ.*, 61, 38, 1925; S. Goudsmit, *Zs. für Phys.* 32, 794, 1925; W. Heisenberg, *Zs. für Phys.* 32, 841, 1925; F. Hund, *Zs. für Phys.* 33, 345; 34, 296, 1925.

¹⁰ J. C. Slater, *NATURE*, 113, 307, 1924. see also N. Bohr, H. A. Kramers and J. C. Slater, *Phil. Mag.*, 47, 785, 1925.

¹¹ H. A. Kramers, *NATURE*, 113, 673; 114, 310, 1924.

¹² H. A. Kramers and W. Heisenberg, *Zs. für Phys.* 31, 681, 1925.

¹³ A. Smekal, *Die Naturwissenschaften*, 11, 873, 1923.

¹⁴ H. C. Burger and H. B. Dorgelo, *Zs. für Phys.* 23, 258, 1924; L. S. Ornstein and H. C. Burger, *Zs. für Phys.* 24, 41, 28, 135; 29, 241, 1924; W. Heisenberg, *Zs. für Phys.* 31, 617, 1925; S. Goudsmit and R. de L. Kronig, *Die Naturwissenschaften*, 13, 90, 1925; H. Honl, *Zs. für Phys.* 31, 340, 1925; R. de L. Kronig, *Zs. für Phys.* 31, 885, 33, 261, 1925; A. Sommerfeld and H. Honl, *Ber. Berlin Akad.* 141, 1925; H. N. Russell, *NATURE*, 113, 835, 1925.

during the last few years, but they could only in a very artificial way be included in the schemes governed by the rules of quantisation.

AN ATTEMPT AT A RATIONAL QUANTUM MECHANICS.

Quite recently Heisenberg,¹⁵ who has especially emphasised these difficulties, has taken a step probably of fundamental importance by formulating the problems of the quantum theory in a novel way by which the difficulties attached to the use of mechanical pictures may, it is hoped, be avoided. In this theory the attempt is made to transcribe every use of mechanical concepts in a way suited to the nature of the quantum theory, and such that in every stage of the computation only directly observable quantities enter. In contrast to ordinary mechanics, the new quantum mechanics does not deal with a space-time description of the motion of atomic particles. It operates with manifolds of quantities, which replace the harmonic oscillating components of the motion and symbolise the possibilities of transitions between stationary states in conformity with the correspondence principle. These quantities satisfy certain relations which take the place of the mechanical equations of motion and the quantisation rules.

That such a procedure actually leads to a self-contained theory sufficiently analogous to classical mechanics depends essentially on the fact that, as Born and Jordan¹⁶ were able to show, there exists in Heisenberg's quantum mechanics a conservation theorem analogous to the energy law of classical mechanics. The theory is built up in such a way that it is automatically in harmony with the postulates of the quantum theory. In particular, the frequency condition is fulfilled by the values for energies and frequencies derived from the quantum mechanical equations of motion. Although the fundamental relations which take the place of the quantisation rules involve Planck's constant, quantum indices do not appear explicitly in these relations. The classification of stationary states is based solely on a consideration of the transition possibilities, which enable the manifold of these states to be built up step by step. In brief, the whole apparatus of the quantum mechanics can be regarded as a precise formulation of the tendencies embodied in the correspondence principle. It must here be mentioned that the theory fulfils the requirements of Kramers' dispersion theory.

Owing to the great difficulties of the mathematical problem involved, it has not yet been possible to apply Heisenberg's theory to questions of atomic structure. From the above brief description it will be understood, however, that a number of results, which, like the expression for Rydberg's constant, had formerly been obtained on the basis of mechanical pictures by the aid of the correspondence principle, will retain their validity.¹⁷ Moreover, it is of the greatest interest that

already in the simple cases for which up to now a treatment on the basis of Heisenberg's theory has been carried out, the new theory leads, besides, to a quantitative calculation of the transition probabilities and to energy values for the stationary states, which differ systematically from those obtained by the quantisation rules of the older theory. One may therefore hope that Heisenberg's theory will be helpful in the struggle with the puzzling difficulties, mentioned above, in the study of the finer details of the spectra.

Earlier in this paper mention was made of the fundamental difficulties involved in the construction of pictures of the interaction between atoms either by means of radiation or by collisions. These difficulties seem to require just that abandoning of mechanical models in space and time which is so characteristic a feature in the new quantum mechanics. As yet, however, the formulation of this mechanics takes no account of the coupling of transition processes in pairs which shows itself in those interactions. In fact, only those quantities which depend on the existence of the stationary states and the possibilities of transitions between them occur in the new theory, which definitely avoids any mention of the times at which transitions take place. This restriction, however, which is typical of the attack on the problem of the constitution of the atom based on the postulates of the quantum theory, allows only some aspects of the analogy between the quantum theory and the classical theories to come to light. These aspects belong principally to the radiative properties of atoms, and just here Heisenberg's theory represents a real advance. In particular it allows us, in the phenomena of scattering, to recognise the presence of electrons bound in atoms in a way completely analogous to the classical theories,¹⁸ which, as stated above, in the hands of J. J. Thomson enabled the number of electrons in an atom to be counted from measurements of scattering of X-rays. The problems arising out of the validity of the conservation laws in atomic interaction involve, however, quite other aspects of the correspondence of the quantum theory with the classical theory. These are equally essential in the general formulation of the quantum theory and it is impossible to avoid discussing them when the reaction of atoms to swiftly moving particles is more closely studied. It is just here indeed that the classical theories have contributed so fundamentally to our knowledge of atomic structure.

It will interest mathematical circles that the mathematical instruments created by the higher algebra play an essential part in the rational formulation of the new quantum mechanics. Thus the general proofs of the conservation theorems in Heisenberg's theory carried out by Born and Jordan are based on the use of the theory of matrices, which go back to Cayley and were developed especially by Hermite. It is to be hoped that a new era of mutual stimulation of mechanics and mathematics has commenced. To the physicists it will at first seem deplorable that in atomic problems we have apparently met with such a limitation of our usual means of visualisation. This regret will, however, have to give way to thankfulness that mathematics, in this field too, presents us with the tools to prepare the way for further progress.

¹⁸ Compare H. A. Kramers, *Physica*, Dec. 1925.

¹⁵ W. Heisenberg, *Zs. für Phys.* 33, 879, 1925.
¹⁶ M. Born and P. Jordan, *Zs. für Phys.*, to appear shortly. The writer is obliged to the authors for the opportunity of seeing their paper in proof.

¹⁷ Note added in proof. Dr. Pauli has very kindly informed me of his success in making the new theory account quantitatively for the Balmer formula for the hydrogen spectrum as well as the influence on this spectrum of electric and magnetic fields. This is a very important result, since Pauli's analysis shows how the new theory avoids the difficulty involved in the older account of the spectral evidence in the necessary exclusion of the stationary states corresponding to singular solutions of the electronic motion.



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Co-operative Research.

AT the first meeting of the British Association, held in 1831, the Rev. W. Vernon Harcourt proposed that the Association should "employ a short period of every year in pointing out the lines of direction in which the researches of science should move; in indicating the particulars which most immediately demand attention; in stating problems to be solved and data to be fixed; in assigning to every class of mind a definite task; and suggesting to its members that here is a shore of which the soundings should be more accurately taken, and there a line of coast along which a voyage of discovery should be made." This early suggestion adumbrating the organisation of scientific research met, apparently, with no response, and academic research continued to be conducted entirely on individualistic lines until a few years ago, when a Government department undertook the organisation of certain investigations which were realised to be of fundamental and national importance. In applied science the picture is a different one. Whereas the field for academic research is so vast and so ever-widening that the fear of duplication or mutual interference seldom arises, the problems of applied science, though very numerous, are more restricted in range, and therefore more amenable to organisation. For a long time past, organised research has been carried out by a few large manufacturing firms, but it was not until the British nation recognised, early in the War, that its existence depended upon certain industries which were based upon science, that steps were taken by Government to organise industrial scientific research.

If our ancestors, who were reared on the doctrines of *laissez-faire* and self-help, could see us to-day, they would marvel at the developments which have sprung Minerva-like from the bitter experiences of the War. As Sir Thomas Holland recently reminded us in his excellent address to the Royal Society of Arts on "The Organisation of Scientific Research throughout the Empire," the seeds of State-aided organisation of science were sown well back in the nineteenth century, but the credit for having transformed "an amorphous mob of scientific workers" into something resembling "an organised army" belongs to the Department of Scientific and Industrial Research. This Department, acting under a committee of the Privy Council, has never looked back since it was established in 1915, and the annual record of its activities has become a document equally important and interesting to the man of science and to the student of public affairs.

The latest report, covering the year 1924-25, of

which a summary is given elsewhere in this issue, deals with a large variety of topics, which are far too numerous to discuss in a single article, and it is therefore proposed to confine attention mainly to a matter which is becoming more and more important: the position of the research associations. These associations, it will be recalled, were founded with the direct object of assisting the industries of the country; a sum of 1,000,000*l.* (called the Million Fund) was allocated for this purpose, and disbursements from it were planned on the excellent principle that the State should help only those industries which can help themselves. Grants were to be made on the basis of 1*l.* for every pound subscribed by the industry concerned, and they were to be continued for a maximum period of five years, after which, it was anticipated, the associations would be self-supporting.

Experience has shown not only that this basic idea was thoroughly sound, but also that it has been admirably applied by the Department. The only rift in the lute is the general conviction that the limitation of State aid to a period of five years was a miscalculation. To what extent this error is admitted by the authorities, we do not know, but the fact that grants to many of the associations have been extended on a reduced scale (block grants of diminishing amount) seems to show that they share the general conviction. There is no doubt that the five-year period is inadequate. Devising a programme of research and planning its details, collecting an efficient staff, providing laboratory and other accommodation, are all slow processes; but the time required for these purposes is in most cases almost insignificant compared with that required to convince the manufacturer of the value of scientific research both to him and to the nation. It must, however, in fairness be stated that many manufacturers came in promptly. The success achieved in this direction can only be surmised, and it is to be hoped that the Department will publish figures showing not only the percentage of firms in each industry that have joined its association, but also the percentage of capital invested in the industry that is represented in the association.

Of the twenty-one research associations now in active operation, those connected with scientific instruments and photography have probably obtained the greatest measure of numerical support from the manufacturers concerned, and these are followed by the associations attached to the cotton and woollen industries; but the comparative non-success of other associations in no way reflects upon their management or upon the Department. Conditions vary very widely in the different industries, and some associations have encountered more opposition or reluctance than others from firms the refusal

of which to co-operate has been matched only by abiding faith in empiricism and trade secrets. No one can envy directors of research who meet with opposition of this kind, and the fault lies with the supineness of the nation to science in general rather than with individuals.

The Department, we understand, has been very successful in directing the choice of directors of research, upon whom so much depends, and in allowing them a free hand. The director has not only to organise and direct research, to conduct the business affairs of his association, but also everywhere to be in contact with the human factor, in the handling of his own staff, and in maintaining amicable relations with the personnel of his constituent firms: it is all-important that he should be on the best terms with the scientific heads of these firms, for this is a vital link in the chain of efficiency. His task is also influenced by the composition of his subscribing firms: an association of which the membership consists of one or two powerful corporations and a few small firms is much more difficult to direct than one of which the constituents are homogeneous, and the difficulties may be said to vary directly with the disproportion between the percentage of invested capital represented in the association and the percentage of firms in the industry that have joined it.

As we have said above, experience has shown that a research association cannot become self-supporting in five years; in view of this fact, of the comparatively small cost incurred (about 100,000*l.* per annum), and of the success already achieved, it is unthinkable that Government will cease to give adequate support after the exhaustion of the Million Fund. At the present and prospective rates of expenditure, the balance that remains (518,200*l.*) will not last for more than a few years. The interest on the unexpended balance has recently been spent on other projects—a possible point of criticism—but it has now been decided to carry forward for future expenditure the sums accruing under this head, although the precise way in which they are to be spent is not specified. Sir Thomas Holland (*Journal of the Royal Society of Arts*, Nov. 20, 1925) has done good service in showing how small, in comparison with the values of the trades concerned, are the sums required to continue the work of the associations; thus, the annual cost of research on cotton, wool, and rubber would be covered by adding $\frac{1}{4}$ *d.*, 1*d.*, and $\frac{1}{2}$ *d.* respectively to each *l.*'s worth of imported raw material. Given adequate support on existing lines, there is every prospect that the research associations will establish themselves as indispensable adjuncts of the industries with which they are connected.

Of the more distant future, one can speak with less assurance and with less optimism. For years past there has been a marked tendency for industrial firms to amalgamate, or to pool their resources and interests in other ways, the latest development in this direction being the unification of all the large German chemical companies into a huge corporation with a capital of about 32,000,000*l.* To what extent such aggregations are desirable from the points of view of the home consumer and the nation is a matter of opinion, but there is no doubt that large corporations can, and do, dispense with extraneous aid in carrying out all the research work they require, whether it be fundamental or incidental.

An interesting feature of the annual reports of the Department are the occasional references to matters of wider import than those which come strictly within its purview. In the present report it is stated that "the embarrassments and losses that the staple industries of the country are suffering are, in our belief, not primarily due to the neglect of science." Approval or disapproval of this statement will depend upon the connotations of the words "science" and "primarily." Most of our recent troubles, including unprecedented taxation, can be traced directly to the War, the occurrence and persistence of which were strongly favoured by lack of scientific foresight and scientific knowledge (*e.g.* of the basic materials glycerin, cotton, etc.), and not least, by the impotence of science, and other purely intellectual disciplines, to restrain or subliminate those primitive instincts of pugnacity and accretion which are "primarily" responsible for war.

There will be less diversity of opinion concerning the truth of the Prime Minister's statement (quoted in the report) that our trade will never be able to cope with unexpected emergencies, at home or abroad, until scientific method and scientific men occupy a better position in industrial affairs. Why the position of the scientific man is inferior to that of the financier and administrator, to what extent he himself is responsible, and how far it is due to the inherent and uncorrected perversity of others, are questions outside our present scope, but they all seem to centre around the larger problem of how to bring home to the people a sense of the actual and potential value of science in the maintenance and perfection of human life. Much of that value lies in research; and just as Malebranche declared that if he held truth captive in his hand, he would let it escape, so that he might pursue and capture it again, so we may say that if we held world supremacy in science and industry, we would let it go, so that we might be forced to use research in the struggle to regain it.

The Question of Race and Hormones.

Process of Physical Growth among the Chinese. By S. M. Shirokogoroff. Vol. 1: The Chinese of Chekiang and Kiangsu, measured by Dr. V. Appleton. Pp. vi+137. (Shanghai: The Commercial Press, Ltd., 1925.) 6 dollars.

THIS well-printed volume, dealing with a comparison of the process of bodily growth in two groups of Chinese, is one of a series of valuable studies of eastern Asiatic peoples undertaken by the anthropologist of the Museum of the Russian Academy of Sciences. Before he left Russia in 1917, Mr. Shirokogoroff was investigating the non-Chinese population of northern Asia: but when the circumstances of the times created obstacles that made it impossible for him to measure the children of Tungus, Manchu and Mongolian peoples, he transferred his attention to China. Dr. V. Appleton not only placed at his disposal her observations and measurements of 900 children made in the mission schools of Ningpo and Hangchow in Chekiang province, and at Shanghai in Kiangsu province, but also provided technical assistance for making the laborious statistical calculations. Dr. Appleton examined and measured the children of both sexes, and girls up to twenty years of age. Mr. Shirokogoroff made the measurements of adult men, for the interpretation of the process of whose growth he used the figures relating to the boys in his colleague's series.

The bulk of the volume is a collection of data rather than an argument that a reviewer can summarise. The author claims that the process of growth in the Chinese differs from that of other "ethnic groups"—he objects to the use of the word "race" and protests against the phrase "Mongol race" as "a baseless hypothesis." According to him, the Chinese differ from all other ethnic groups in the very pronounced and abrupt retardation of growth at the age of fifteen to sixteen years, and an equally distinctive acceleration four years earlier. His arguments are backed up by many tables of measurements and comparisons with data relating to other peoples, and statistical studies of the figures.

As Mr. Shirokogoroff explains in his introduction, the problem of interpreting the nature of physical growth is the real aim of his treatise; and he sets out to solve it by claiming that the "process is regulated, on one hand, by the interaction of the glands of internal secretion and metabolism which depend on heredity, and on the other hand, by the conditions of environment." He has made no observations of the endocrine glands. The argument is: the Chinese differ from other peoples in certain physical characters and mental aptitudes; therefore their ductless glands must be functioning in a different way from those of other people; hence

the physical characters and mental aptitudes of the Chinese have distinctive qualities! It is enough for him to accept without question Sir Arthur Keith's gay theories (*NATURE*, November 13, 1919; and *Johns Hopkins Hospital Bulletin*, 1922, pp. 155 and 195) as though they had been proved by observation or experiment, instead of being mere suggestions, which have never been seriously investigated or substantiated.

Mr. Shirokogoroff devotes a whole chapter to the "endocrine differences of the Chinese," which he sums up in the statement that "the endocrine complexes define not only the process of physical growth, but the psychic behaviour of ethnical units, so that the peculiarities of Chinese psychology and behaviour may be explained as the result of their glandular complexes." But when he becomes more explicit the fanciful nature of his argument is more clearly revealed. The longer legs of the Chinese infant, which the comparison of his measurements with those of other races indicates, are claimed to be due to the fact that "the pituitary gland is not inhibited by the thymus or pineal or sexual glands so intensively as among other ethnical groups. Among the Chinese of Chekiang it seems to be more active during the early period than among the Chinese of Kiangsu. Among both Chekiang and Kiangsu males this period is preceded by retardation (*vide supra*), which, we suppose, may be due to the inhibiting character of the sexual glands." In this strain of uncontrolled speculation Mr. Shirokogoroff devotes three pages to the process of building up a wonderful house of cards!

These statements are made without citing any evidence in support of them, or any data to suggest that there is any recognisable difference in the endocrine organs or their functional activities of the Chinese people. The only justification he offers for this vast claim is the reference to Sir Arthur Keith's views (which are also unsubstantiated by any control of experiment or observation) and Prof. Shellshear's observation that the thymus often persists throughout life in the Chinese. It is not uncommon to find an apparent persistence of the thymus in European adults; but as a rule histological examination reveals the fact that in such cases the distinctively thymic tissue has disappeared. Hence, until it has been checked, Shellshear's claim—the only anatomical fact so far adduced in support of the endocrine hypothesis—cannot be accepted as conclusive evidence.

In recent years the endocrine glands have been so widely exploited in applied medicine and in biological speculation, that one views with increasing suspicion the appeal to hormones to solve any difficulties for which no adequate explanation can be found. In such circumstances, Sir Michael Foster's maxim that a hypo-

thesis not tested by observation or experiment is of no value in science should be applied with the utmost stringency. As my colleague, Prof. T. R. Elliott, said some years ago with reference to this very subject of the interrelationships of endocrine organs: "Medicine owes no debt of gratitude to those who teach to her theories without proof." Probably in all processes of growth and development hormones are exerting a regulating influence; but crude analogies between the effects of disease on the thyroid, pituitary, or suprarenal organs and the differentiation of races will not promote but hinder the progress of science, unless the serious attempt is made to collect evidence in proof (or disproof) of the claims made for such specific endocrine influence.

Perhaps the only coherent argument in support of such an evolutionary factor was made by Prof. Bolk, of Amsterdam, when he attempted to interpret (*Lancet*, 1921, vol. 2, p. 588) the derivation of the distinctively human traits from those of an ape by the restraining influence of the hormones, in virtue of which man retained the characters of the simian infant into adult life. His argument was pursued with such logical intentness that he seemed not to be abashed at the paradoxical conclusion. For, according to Prof. Bolk, the human brain, man's distinctive attribute, was acquired not by the active growth of a progressively developing organ, but simply by the inertia of a tissue that retained the relative proportions it had in the foetal ape!

In all these speculations, fascinating by the very fact that they are so obviously fantastic, it seems to have been overlooked that while endocrine activity may influence the structure and metabolism of an individual and control his desires and behaviour, there is, as yet, not a scrap of evidence to prove that it plays the part of the determining factor in evolution which Mr. Shirokogoroff so confidently assumes.

The value of his volume depends wholly upon the new data he and his collaborator have so laboriously collected. Those whom he thanks in his preface for help in his "struggle with English" have not earned the gratitude he so generously bestows.

G. ELLIOT SMITH.

Sound Signalling.

The Principles of Sound Signalling. By Morris D. Hart and W. Whately Smith. Pp. v+139. (London: Constable and Co., Ltd., 1925.) 12s. 6d. net.

THE problem of sound signalling over considerable distances has a most important application to the question of safety of ships at sea in thick and foggy weather. This application, in the case of a maritime country like Great Britain, is probably more important than any other application of sound signalling.

From the time when Tyndall made his celebrated experiments on the transmission of sound signals through the atmosphere, much attention has been paid to the subject, but more particularly during the last ten or twenty years. Tyndall found, and it is now common knowledge, that the radius at which a sound may be heard is largely dependent on the state of the atmosphere. Apart from the effects of wind, large areas of silence have been observed in different directions and at different distances (sometimes small) from a source of sound. The loudness of the received sound, therefore, is no criterion of the distance from the source. The direction of the sound as perceived is not necessarily that of the actual source.

In view of these facts, both of serious import to ships in fog, a new system of sound signalling has originated in which the medium of transmission is no longer the fickle atmosphere but the much more homogeneous medium—the sea. Sound signals will travel great distances in the sea with little attenuation (when compared with that in the atmosphere) and with no observable change of direction. In the sea, areas of silence are unknown, and accuracy of directional reception is very great, within one or two degrees.

Both systems of sound signalling are in regular use around the coasts of Great Britain as well as those of other European countries, Canada, and North and South America. In addition to these systems of signalling, radio-direction finding is now rapidly increasing in its use and may ultimately supersede the older acoustic methods. A combination of radio-acoustic signalling, which gives a ship its exact position at sea, has also been tried with success by the Admiralty and by Trinity House.

The volume under consideration, although assuming the comprehensive title “The Principles of Sound Signalling,” deals only with the case of atmospheric transmission of sound. The principles discussed are, therefore, applicable only to sounds in air, and are in general quite unsuited to the problem of sound signalling in water. These important points might, with advantage, have been indicated in the title or the preface of the book.

The first chapter deals with the question of “efficiency” in acoustics. Here the authors are somewhat pedantic regarding the popular use of the word. They appear to overlook the fact that the popular meaning is correct; it was in daily use *before* the engineer and physicist employed the word in its narrower sense, namely, “the ratio of power-output to power-input.”

The processes of production, transmission, and reception of sound are each analysed and the efficiency of each subdivision, more than ten in all, is indicated by a special symbol. Although the authors may have found

it convenient to employ these numerous efficiency symbols, the reader may find them somewhat bewildering. Regarding the principles and methods of reception of sound, dealt with in the second chapter, very scanty consideration is given to the better known forms of receiver. The authors apparently consider that all forms of receiver other than the unaided ear and the Tucker hot-wire microphone are of no importance. It is made quite clear that the hot-wire microphone in conjunction with a suitable Helmholtz resonator is particularly suitable for low frequency sounds, but no alternative is given for reception at higher frequencies. A statement is made later, on p. 121, that most sound-signalling apparatus is intended to work in conjunction with the ear, but no apparatus is described (other than the recognised amplifying and collecting devices by mirrors, resonators, and trumpets) which can assist the ear at the higher frequencies at which it is most sensitive and where the hot-wire microphone becomes more and more insensitive. A hot-wire microphone and reflecting galvanometer, however valuable for research purposes, would be of doubtful assistance to a navigator in a fog—the sound signal must be heard and an approximate direction perceived.

The two chapters on transmission of sound are very interesting, the deductions relative to the size and intensity of sources of sound being of considerable practical value. The second chapter on transmission deals with the fundamental difficulty of sound signalling in air, namely, the capricious effect of atmospheric conditions. In addition to the refraction effects produced by wind, temperature gradients, fog banks, and patches of dry air, are other important causes of abnormal changes of intensity and direction of a sound wave. The effect of humidity is well illustrated in the Joss Gap records reproduced on pp. 65 and 66. The value of these chapters on transmission might have been enhanced by the inclusion of data relative to attenuation (other than simple spreading and effects of large amplitudes) over long distances. The attenuation in transmission of sound through the sea is known to be a more important factor than the loss of amplitude due to spreading—it is conceivable that this is so also, and perhaps to a greater degree, in the case of sound transmitted through the atmosphere.

On p. 93 are enumerated twelve important features desirable in a source of sound for signalling purposes, and reasons are afterwards given for considering the centrifugal siren as superior to other forms of source. This information combined with the conclusions reached in the chapters on transmission should prove of considerable value to the acoustic engineer, who is primarily concerned with the production and transmission of sound over great distances. A statement on the lines of the:

summary given on pp. 101-103 would have served as a useful introductory to the book.

The concluding chapter dealing with "Miscellaneous Considerations and Conclusions" might with advantage have been extended. Only five pages of the book are devoted to the choice of pitch, quality, and type of signal, whereas eighteen pages were devoted to a general discussion of the exact meaning of efficiency and the subdivision of the signalling process into many efficiency stages. Data relative to the transmission of sounds of different frequencies would have added greatly to the value of the book—but this section is dealt with in a few brief remarks.

Appendices III. and IV., on the measurement of acoustical energy and on experiments with sources of sound, are very instructive to any one interested in this subject.

Taken as a whole, the book gives a good indication of principles to be considered in the design of sound-signalling apparatus for use in air, and supplies also much information relative to that branch of recent acoustical work carried out by Major Tucker and his staff on behalf of the Royal Engineer Board.

A. B. W.

Birds of Ceylon.

Manual of the Birds of Ceylon. By W. E. Wait. Pp. ii+496+20 plates. (Colombo: Colombo Museum; London: Dulau and Co., Ltd., 1925.) Rs. 10 (15s.).

SINCE Legge published his magnificent volumes on the birds of Ceylon, no attempt has been made to bring out any complete handbook bringing up-to-date and collating what is known about the ornithology of the island. Legge's work appeared in 1880, and though this work is still of the greatest use to any working ornithologist, it is expensive, very bulky and, naturally, in many ways completely behind the times. Mr. Wait now presents us with a single volume containing almost as much information as that contained in Legge's book, and also information that is thoroughly up-to-date and scientific. The classification adopted by Mr. Wait is that of Stuart Baker in the second edition of the "Avifauna of British India," which is now in course of production. No classification in zoology can, of course, be accepted as final, and though Stuart Baker's book is the latest work on the subject, as time goes on, alterations will have to be made in his work, even as he had to make alterations in the work of those preceding him. The author of "The Birds of Ceylon" has, however, done wisely in adopting the classification of a work with which it will undoubtedly be constantly compared by every ornithologist and field naturalist in the course of his work.

Mr. Wait has given us the scientific and trivial name of each species and sub-species dealt with; he then gives the vernacular names and a brief synonymy; a

good description of the bird dealt with in its various phases of plumage and, finally, its distribution and most excellent field notes. The author himself is not only a scientific ornithologist, but is also a keen field naturalist, so that he has been able to add from his own knowledge much of interest and value to the oft-quoted notes of Legge, Holdsworth, and others. A very good outline map accompanies the letterpress, and on this is shown the amount of rainfall in the various districts, a most important matter in an island like Ceylon, where we have an extraordinary variation in the rainfall, affecting the flora generally and therefore the fauna also.

The total number of birds dealt with by Mr. Wait is 372, a very great increase when we compare it with the number about which Legge had to write in 1880. This number in Ceylon is not much affected by the modern method of dividing species into sub-species, for there are but few cases in which species are represented by more than one geographical race in this island, and we notice that in one of the few species which in Ceylon has been divided into two sub-species, that is, *Pellorneum fuscicapillum*, Mr. Wait has suppressed *P. f. babaulti* of Wells, perhaps with sufficient reason.

Some of the most important work which the author of this volume has been able to carry out is the proper identification of many of the older skins contained in the Colombo Museum, where his careful and painstaking work has resulted in many novelties coming to light, as well as the addition of a considerable number of most interesting birds to the Ceylon avifauna. The most important of these are *Puffinus carneipes carneipes*, *Parasula dactylatra persomata*, *Puffinus leucomelas* and *P. pacificus hamiltoni*.

At the end of the volume, Mr. Wait gives us 20 excellent plates containing nearly 100 figures in black and white of the birds of Ceylon. There are few students who will not be able to recognise the birds they come across from these plates alone, and they undoubtedly add considerably to the utility of the volume. The general appearance of the book is quite satisfactory, the printing and paper all that can be desired, whilst printers' errors are conspicuous by their absence. We congratulate Mr. Wait on having produced a book which has long been wanted and fulfils admirably the purpose for which it was written.

Our Bookshelf.

Cloud Studies. By Arthur W. Clayden. Second edition. Pp. xv+200+64 plates. (London: John Murray, 1925.) 15s. net.

WHILE the international classification of cloud forms comprising ten separate types is of the utmost value in world meteorology, it can scarcely be expected that it will satisfy completely the needs of those meteorologists who specialise in cloud study. One is accord-

ingly prepared when opening a book like "Cloud Studies" to find some amplification of the international classification, but it may be doubted whether the separation of clouds into forty named types really serves any useful purpose. Such a system must inevitably be too cumbersome for use in the daily work of meteorological observatories, and stands no chance of obtaining general acceptance. It may also be remarked that although Mr. Clayden pays lip service to the international classification, he makes it plain that in certain important respects he is not in agreement with it.

It is not intended by these criticisms to suggest that the book should be avoided or that it is unworthy of study either by meteorologists or the general public. On the contrary, it may certainly be read with profit and pleasure derived from the numerous cloud photographs with which it is illustrated. The most important change from the first edition published twenty years ago is the inclusion of a chapter on the formation of clouds, in which stress is rightly laid upon the primary importance of dynamic cooling in cloud production. Another useful chapter is devoted to the subject of cloud photography.

For the observation of clouds the use of a mirror of black glass is recommended, the reflected image of the cloud being observed. The same device has been used in obtaining many of the cloud photographs. The printer does not seem to have done full justice to all of these, the delicate texture of the high clouds being in some cases lost. Others are entirely admirable, among which may be mentioned Plate 36 which represents "Alto-cumulus Castellatus Fractus."

J. S. D.

Ergebnisse der exakten Naturwissenschaften. Herausgegeben von der Schriftleitung der *Naturwissenschaften*. Vierter Band. Pp. iii + 242. (Berlin: Julius Springer, 1925.) 15 gold marks.

THE 1925 volume of the "Ergebnisse der exakten Naturwissenschaften" contains eight articles. Dr. J. Stracke deals with the minor planets historically, treating their brightness, diameters, total mass, the statistics of the elements of the orbits, groups the orbits of which show great similarity, planets with unusual orbits, such as Eros, which is often closer to the sun than Mars, and Hidalgo, which at its aphelion is nearly as far from the sun as Saturn. The article gives a short account of the theories of the origin of the minor planets.

Prof. A. Prey's article on the theory of isostasy treats the development and the results of the theory; he does not consider it possible to account for mountain building by means of this theory alone, horizontal thrusts also being necessary. Prof. A. v. Brunn considers that for astronomical purposes the empirical time concept retains its importance, in spite of the Minkowski-Einstein conception. Prof. A. Wehnelt gives an account of oxide cathodes and their practical applications, and Dr. G. Heckmann of the lattice theory of solids, dealing with stability and energy relations, mechanics and electrostatics, acoustics, optics, thermodynamics, ionic lattices, atomic and molecular lattices. Dr. I. R. Katz investigates the swelling of such substances as rubber, nitrocellulose, and acetylcellulose, when soaked in certain organic liquids, the process

being studied by X-ray methods. Dr. W. Hanle's article is on the influence of magnetism on resonance fluorescence, *i.e.* fluorescence occurring when the exciting light has the same wave-length as the natural vibration of the atom; and that of Prof. Strömberg deals with the orbit forms in the problem of three bodies.

A Practical Treatise on Fourier's Theorem and Harmonic Analysis: for Physicists and Engineers. By Albert Eagle. Pp. xiv + 178. (London: Longmans, Green and Co., 1925.) 9s. net.

HARMONIC analysis appeals both to those interested in the mathematical eccentricities exhibited by Fourier expansions and to those concerned merely with the practical question of analysing empirical data into their constituent harmonics. The present volume, by catering in an interesting manner for the latter class, endeavours at the same time to focus the interest of its members on problems of more theoretical importance. In many respects the treatment is novel, and differs materially from that adopted in text-books of this nature. One is accustomed on picking up a "practical" book on harmonic analysis to find the usual medley of special methods unco-ordinated by any guiding principle for determining the coefficients. While certain of these find their place here, the author has centred a great part of his discussion around the expression for the coefficients in terms of the discontinuities of the function to be analysed and its successive differential coefficients, and on this as a basis he develops a number of elegant and at the same time comparatively accurate approximations to the coefficients. In practice these expressions are in a form suitable for numerical computation.

On the theoretical side, however, the book exhibits weakness in parts. There should scarcely be any necessity in such a work for a special section on the meaning of complex numbers, while the derivation of the power expansions for $\sin x$ and $\cos x$ from Demoivre's theorem and the evaluation of $\int \frac{\sin x}{x} dx$ are splendid examples on how *not* to treat limits. Altogether an interesting and valuable book, though slightly marred in places by elementary weaknesses and an irregular style.

Guide to Current Official Statistics of the United Kingdom. Vol. 3 (1924). Pp. 252. (London: H.M. Stationery Office.) 1s. net.

THIS guide consists of three main parts: a numbered list of official publications that contain statistics; a subject-index, giving under each entry the list-number of each publication containing relevant statistics, and some indication of their nature; a key from which the converse may be discovered, namely, the kind of statistics found in each publication. This last is of undoubted value; but we cannot see why the same information should not be more cheaply and conveniently given by adding the page-numbers to which reference is made after each entry in the list of titles, and in saying this we speak from practical experience with a similar publication.

The subject-index, on which the value of such a work depends, has been drawn up with much skill;

any reader who follows the instructions should certainly run down his quarry. If he cannot at once hit on an appropriate reference, he will find it by working down from one of the twenty-five main headings. The heading that will attract most of our readers is "Research." Under this are only two direct entries, but a cross-reference is given to the following, of which those italicised are also main headings: *Agriculture*, *Atmospheric Pollution*, *Fisheries*, *Forestry Commission*, *Fruit and Vegetables*, *Industrial Fatigue*, *Medical Research*, *Mining (General)*, *Radio Research*, *Royal Aircraft Works*, *Statistical Methods*, *Vivisection*. One would have expected references to yet other subjects. None of these, for example, leads one to the entry "Seismological Data" (which is under *Meteorology*); possibly the accumulation of data is not regarded as research.

The Engines of the Human Body: being the Substance of Christmas Lectures given at the Royal Institution of Great Britain, Christmas 1916-1917. By Sir Arthur Keith. Second edition, revised and enlarged. Pp. xvi+343+2 plates. (London: Williams and Norgate, Ltd., 1925.) 12s. 6d. net.

THE second edition of Sir Arthur Keith's book, "Engines of the Human Body," is remarkable mainly for its appendices, of which there are thirteen. They are added for the purpose of expanding and amending the original text of the book, and indicate the directions of advance in anatomical and physiological knowledge, including subjects such as the needs of the muscles of athletes, the control and education of muscles, the effect of altitude, vitamins, and automatic nerve control. The only point which might be queried is the suggestion that beri-beri is due to lack of vitamin C; the accessory substance the absence of which is responsible for this disease is probably vitamin B.

Although the lectures on which this book is based were delivered to a juvenile audience, it may be read with advantage by student, expert, or any individual interested in the working of the human body. As an elementary explanation of the main facts of physiology, for simplicity of language and clarity of description, it has no equal. To the second year medical student it may be particularly recommended, for it gives him in the original lectures a general survey, and in the appendices some illustrations of modern work, than which he could have no better introduction to the subject of physiology.

Man's Life on Earth. By Prof. Samuel Christian Schmucker. Pp. xxx+299+4 plates. (New York: The Macmillan Co., 1925.) 10s. net.

DR. SCHMUCKER is skilled in the art of popular exposition. From this point of view his little book leaves little to be desired. It covers the conditions precedent to man's life on earth as revealed by geology and palæontology, as well as the evolution of man and his cultural history. The author shirks no difficulty and boldly tells his readers when any conclusion which he sets down is doubtful and when the evidence is inadequate, inconclusive, or unsatisfactory. He is a fervent admirer of Dr. H. Fairfield Osborn, and in most controversial questions follows that distinguished author. Consequently, his treatment of the

early stages of man's history up to the beginning of the Neolithic period is both fuller and more satisfactory than it is for the later periods, where he is uncritical and not always exact. He accepts, for example, Pumpelly's very high dating for Anau, and his account of the rise of European culture is sketchy at best. The book is written for the American public; but two features will be helpful to English readers. One is a very clear account of the evidence for the Ice Age in America so far as ascertained; the second is an analysis of the peculiar social conditions in the United States which gave rise to the evolution controversy and culminated in the Dayton trial after this book was written.

Ethnographical Studies in Celebes. Results of the Author's Expedition to Celebes, 1917-1920. By Dr. Walter Kaudern. 1: Structures and Settlements in Central Celebes. Pp. xiii+404+6 maps. (Göteborg: Elanders Boktryckeri A.-B., 1925.) n.p.

IN this volume Dr. Kaudern gives the first instalment of the results of an expedition, in the course of which some three and a half years were spent in the island of Celebes. He expects to complete his work in about ten volumes, each of which will be devoted to some aspect of native culture. Here he deals with the structures and settlements of N.W. Central Celebes, the home of the Mountain Toradjas. Some of the Toradja tribes have been visited by those well-known explorers, the brothers Sarasin, and by Dr. Kruijt. The author, however, so far as possible, confined his investigations to tribes which were practically unknown and untouched by civilisation. In regard to his special theme in this volume, his investigation was to some extent complicated by the slavery resulting from tribal warfare, which has affected the type distribution of houses and temples; but by a skilful analysis, which calls for no little praise, he has distinguished three types in the houses, paddy-sheds, and temples, one of which is of recent introduction, possibly of Chinese origin, and of the remaining two, one appears to be the primitive type of which the form was determined originally by its location on swampy ground.

A School Mechanics. By C. V. Durell. (Cambridge Mathematical Series.) Part 2. Pp. xv+187-322+xi-xvii. Part 3. Pp. xi+323-447+xix-xxvi. (London: G. Bell and Sons, Ltd., 1925.) 3s. each.

IN these two small volumes, Mr. Durell completes his combined course of statics and dynamics, of which Pt. 1 has already been published. The advantage of taking the two subjects together is less obvious in these later stages, when the selection of the topics to be treated in turn is purely arbitrary, but teachers who think such a procedure is desirable will find no book to compete with this, in which Mr. Durell's unequalled skill in the invention of problems has ample scope.

For moments of inertia the reader is referred to the calculus, which is not otherwise required, as the book-work on rotational dynamics is restricted to the discussion of constant forces only, the compound pendulum being treated by assuming the energy equation. More space might with advantage have been allotted to relative velocity, considering the difficulty it presents to young students.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Highly-penetrating Radiation and Cosmical Physics.

If stellar radiation originates in the annihilation of stellar matter, it seems likely to be generated by quanta of wave-length 1.3×10^{-13} cm., each quantum being produced by the simultaneous destruction of one electron and one proton. Such radiation may be either absorbed or scattered when it encounters matter. The absorption of a quantum will eject an atom with a velocity equal to 0.99999985 time that of light. If this strikes an atom, a new quantum is emitted of wave-length equal to that of the original radiation, the hardness of which thus remains unaltered by absorption and re-emission. Scattering, however, produces a softening, precisely as in the Compton effect, and a succession of scatterings will increase the wave-length of the radiation until it degenerates into ordinary temperature-radiation.

Even newly generated energy cannot travel far through the interior of an ordinary star without being changed in this way. On the other hand, there are astronomical bodies which are transparent to ordinary light, and probably also to high-frequency radiation. The most obvious examples are the irregular nebulae, such as the Orion nebula, and the shells of the planetary nebulae, but the most important to cosmical physics are the spiral nebulae. On any reasonable computation the big spirals such as M. 31 (the great nebula in Andromeda) must be almost transparent to ordinary light, as is indeed shown by the circumstance that bright nuclear points, obviously located at the centre, are visible in many. On the best computation I have been able to make (*Monthly Notices R.A.S.*, April 1925, p. 534), the average optical thickness of M. 31 is only about 1 gram per sq. cm. It follows that these nebulae must be almost completely transparent to newly generated radiation, so that practically the whole of the radiation they generate will escape into space without any change of wave-length. Space must be filled with such radiation, and its penetration into our atmosphere would seem to provide a natural explanation of the highly penetrating radiation recently investigated by Millikan.

On the supposition that the spirals are the birth-places of stars, their radiation-generating capacity per unit mass ought to be at least as great as that of the youngest stars, and these have a capacity equal to about 500 times that of the sun. On the other hand, the visible radiation emitted by the Andromeda nebula per unit mass is only about 0.16 time that from the sun. We conclude that only a 300th part of the total radiation of this nebula is visible. One part in 3000 of the total radiation generated inside the nebula is stopped by matter and transformed into light, while the remaining 2999 parts travel through space as high-frequency radiation.

The integrated light from the Andromeda nebula is about equal to that from a sixth-magnitude star, so that the high-frequency radiation received on earth from this nebula alone must be equal in energy to the visual radiation from a star of magnitude -2.7 . This represents an average fall of energy of 15^4 ergs per second on each square centimetre of the outer boundary of the earth's atmosphere.

To produce a single ion in air requires about 2×10^{-11} ergs (corresponding to an ionisation potential

of 14 volts). To produce an average of 10 ions per cubic centimetre through 10 kilometres of atmosphere accordingly requires an inflow of energy at the rate of 2×10^{-4} ergs per second through each square centimetre of the outer boundary of the earth's atmosphere. Thus the high-frequency radiation from the Andromeda nebula alone would contain sufficient energy to produce about one-half of the observed ionisation. No doubt the radiation which strikes the earth is not all expended in ionising molecules, but when we add the radiation from all the other nebulae in the sky, we seem likely to obtain a total effect of about the observed amount.

The essential point is that the hypothesis we have considered gives the effect of the right order. In this respect it would appear to have the advantage over the possibility, to which Millikan alludes (*NATURE*, December 5, p. 823), of the radiation being caused by nuclear changes such as the formation of helium out of hydrogen; an effect of the observed magnitude, which must presumably continue for millions of millions of years, would seem to require a quite incredible amount of hydrogen or similar matter to be scattered through space.

On our supposition that one part in 3000 of the total radiation is stopped by an optical thickness of one gram, the radiation should be reduced to $1/e$ times its original intensity after traversing 3000 grams per square centimetre, or about eight feet of lead. This corresponds roughly to the penetrating power observed by Millikan, but from it he deduces a wave-length of 4×10^{-12} cms. as against the 1.3×10^{-13} suggested by the annihilation hypothesis. If this latter wave-length can be shown to be inconsistent with the observed penetrating power of the rays, it may become necessary to suppose that annihilation takes place by successive stages, in which case our hypothesis would approximate more closely to that discussed by Millikan.

The interaction of this high-frequency radiation with matter, whether by absorption or scattering, must liberate free electrons moving with velocities almost equal to that of light. The majority of these will escape into free space with practically undiminished velocity. Hitherto we have thought of interstellar space as being traversed only by visible radiation, but one must now think of it as being traversed by super- γ -rays and super- β -rays as well. The effect on cosmical physics must be profound. The bombardment by these rays provides an obvious explanation of the luminosity of such objects as the irregular nebulae, as well as of the negative charge of the earth.

J. H. JEANS.

Mendelian Genes and Rates of Development.

THE genetic research of the last quarter of a century, first especially by Bateson and later by the Morgan school, has given us a remarkable insight into the constitution of the hereditary material. We are now enabled to regard it as mainly or wholly composed of separable units (genes or factors), arranged in definite order and quantitative proportions in a series of groups (linkage-groups = chromosomes), and correlated with the appearance of the visible characters of organisms. However, very little is known as to the developmental mechanism by which this correlation is brought about. We thus have accurate pictures of the gene-complex and of the character-complex, but these pictures are, we may say, static, and the dynamic relations between the two are obscure.

Some progress towards filling this great gap in biological knowledge has been made, for example, by Onslow,¹ in his studies on the relations of genes to

¹ Onslow, *Proc. Roy. Soc.*, Series B, vol. 89, pp. 36-58 (1915).

the production of the substrates and enzymes of pigment formation, and notably by Goldschmidt² in his work on sex-determination, and on larval colouration in moths.

We have found in *Gammarus chevreuxi* a form which is in many ways convenient for the study of such relations. It has been known for some time that the red eye-colour (which arose by mutation from the normal black) darkens with age (Allen and Sexton).³ We have studied this process quantitatively by comparing the eyes of our animals with an arbitrary colour-chart. By this means curves giving the rate of darkening can be obtained (Fig. 1).

Before proceeding further, the relations of the different eye-colours (black and red) must be mentioned. We have worked with the "no-white" form, in which the normal white inter-facetary pigment is not present (another mutation). In the facets of the normal "black" eye, both black and red pigments are present. The former appears to be a melanin: it is insoluble in all reagents tried. The latter, however, is soluble in alcohol, ether, chloroform, and a number of other substances. Their embryonic condition can also be studied. The eggs are laid in a

It was further found that both the time of starting and the rate of the darkening process differed very considerably among the red-eyed individuals. The time of starting is also closely correlated with the rate, and we shall here only consider the latter. The effect of its variation is to produce a range of final eye-colour from an apparently pure red to a deep chocolate easily mistaken for black. A curious point is the existence of a "stable phase" as regards the quantity of black pigment. This is usually reached at sexual maturity, or shortly afterwards. Another complication is found in the fact that immediately after each moult a definite lightening of colour is seen. This, however, disappears in a few hours and the normal curve is resumed.

This difference in rate of darkening in the reds was, we suspected, due to the presence of modifying genes. We accordingly mated up a number of pairs, each consisting of a rapid-darkener and a slow-darkener. The results have confirmed our expectations. The F₁ in all cases but one, showed definite but incomplete dominance of rapidity. In the one exceptional case the brood was divisible into "rapids" and "slows" in a 1 : 1 proportion (15 : 17), indicating that the rapid parent had been heterozygous. From the remaining F₁'s the F₂'s were bred. The results indicated definite segregation, the total numbers obtained being rapid 89 : slow 31.⁴ The variations were much greater among the former class than among the latter, indicating, once more, imperfect dominance among the heterozygotes.

The general bearing of these facts may now be considered. *Gammarus* happens to be an organism which (1) has no metamorphosis, and (2) exhibits continuous growth and differentiation long after sexual maturity is reached: a type of development which must be regarded as primitive. It thus has no single size or form which can claim to be typical. The specific characters of any species of *Gammarus* can be arbitrarily defined with regard to a definite instar (such as that at which sexual maturity is attained), but more logically they should take into account the rates of change of the various organs. In a holometabolous insect, on the other hand, the adult characters appear only at the imaginal phase, and no growth or differentiation occurs after this. In ametabolous insects, and warm-blooded vertebrates, there is continuous change before, but no (or negligible) change after, the attainment of a fixed adult phase.

Thus if *Gammarus* were a holometabolous insect and the same factors were operating in it, we should see merely a cross-section of the curves for the rate of pigment production, as indicated by the line S-S in the diagram. Such a cross-section would give a picture similar to that seen in the effects produced, for example, by multiple allelomorphs in *Drosophila*. We may thus, with some reason, conjecture that the difference between the effects of multiple allelomorphs, and possibly between other quantitatively different characters, are usually to be ascribed to a difference in the rate of formation of some definite substance. Such a substance might accumulate gradually, but

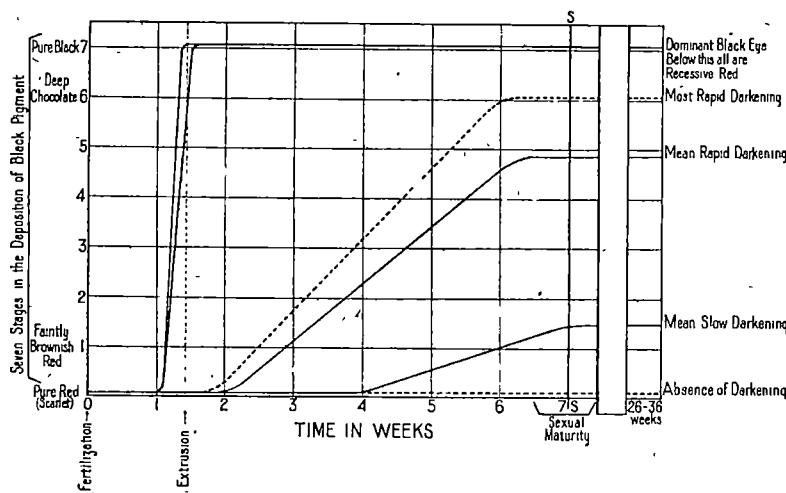


FIG. 1.—Diagram showing rates of darkening of eye in different strains of *Gammarus* (the curves given are purely diagrammatic as to shape).

maternal brood-pouch: here they hatch, but the young are kept in it for some further time before extrusion. It has been found possible to remove the embryos from the brood-pouch a day or more before they would normally be hatched in it, and to rear them successfully outside the body. It is then seen that the eye of the future black-eyed animal is first uncoloured: it then becomes pale pink, and later scarlet. This then starts to darken just at the end of embryonic life. The process continues until, at about the time of extrusion, the full black colour is attained; this being about ten days from fertilisation at a constant temperature of 20° C. The darkening of the scarlet to black is entirely due to the deposition of insoluble melanin.

When the red-eyed individuals are examined, it is found that a similar darkening process occurs in them. The darkening is not due to a change in the red itself, but to a deposition of insoluble black pigment. The rate of deposition is, of course, always much slower than in the black-eyed forms; also the process always starts after extrusion.

² R. Goldschmidt, "The Mechanism and Physiology of Sex Determination," London, 1923. Goldschmidt, Seiler und Poppelbaum, 1924, Arch. f. mikr. Anat. u. Entw. Mech., vol. 101, p. 92.

³ Allen and Sexton, J. Mar. Biol. Assoc., vol. 11, p. 273 (1917).

⁴ These figures are from families with a sharp distinction between "rapids" and "slows", in others they are less easily separated. Presumably more multiple factors are here operative, and the results are being further analysed.

only show its effects suddenly, at a certain developmental stage.

One point here deserves mention. In two specimens of *G. chevreuxi* tested, slight darkening occurred, but starting only *after* sexual maturity; in an insect like *Drosophila* it could not have developed at all! Thus many apparent absences of a character may merely be due to extreme slowness in its development. Captain Diver informs us that similar phenomena are to be observed in the banding of *Helix* spp. It is also worth noting that the recessive "red" character is, at least in almost all cases, not due to an *absence* of black, but only to its slower deposition.

We here get a definite relation between Mendelian factors and the rates of a process which is continuous throughout most of the animal's life. We believe the line of thought thus raised to be a fruitful one for very various genetic problems, and hope that others may be induced to test its wider application.

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Oceanographical Expeditions to the Black Sea in 1924 and 1925.

THE first study of the Black Sea was undertaken by the General Hydrographic Administration of Russia in the years 1890 and 1891. This expedition discovered the peculiar character of this sea.

After thirty-five years, oceanographical views and methods have developed to such an extent that it was necessary to send a new expedition to study the oceanographical conditions of this sea basin.

The same General Hydrographic Administration of the Navy of U.S.S.R. undertook this work. As a first step, a cruise, repeated four times every year, along the meridian of the south cape of the Crimea, was established. Data were thus collected for the study of the seasonal variations of the oceanographical elements in 1923-25.

For the general study of the oceanographical conditions, two special expeditions, in June-July of 1924-1925, were organised, both under my supervision. In 1924 the eastern part of the sea was studied, 1200 nautical miles being covered with 28 stations. In 1925 both eastern and western parts of the Black Sea were explored. During a 36 days' cruise, 2300 nautical miles were traversed with 72 oceanographical stations, 35 of which were in deep water. A total of 4250 observations were taken, amongst which more than 2000 gas analyses were carried out on board. Deep-sea soundings were made and sections of deep-sea deposits were obtained about 60 cm. long.

The material collected during the last expedition is now being examined, but the four seasonal cruises and others have given data which lead to some conclusions on the oceanographical conditions of the Black Sea. The salinity increases from the surface to the bottom from 18 per mille to 22 or 23 per mille at 2000 metres. The seasonal variations disappear at 100 m. The density has a similar vertical distribution, being about 112 at the surface, and reaching 117.4 at the bottom. Seasonal variations also were not met deeper than 100 m. The surface density in any case cannot exceed that at 200 m.; because of this, convection currents do not descend deeper than 200 m.

The vertical distribution of temperature has a peculiar character. The seasonal variations are observed only in the layer of 100 m. deep. At the depth of about 200 m. a layer of constant temperature

is observed—about 8°-7 C. From this depth to the bottom the temperature increases, and in the bottom layer it reaches 8°-92 to 8°-95 C. Near the shores the vertical distribution of temperature is more complicated.

These oceanographical conditions lead to a special vertical distribution of dissolved gas. Oxygen cannot penetrate deeper than the convection currents. In the open sea it reaches 150-160 m. only, near the shores, 200 m. or a little more. The deep layers below 200 m. contain hydrogen disulphide. In the open sea at the depth of 150 m. this gas is present to the amount of about 0.5 c.c. in a litre, at 0° C. and 260 mm. of atmospheric pressure. The quantity increases with depth and in the bottom layer, at 2000 m., it is 6.8-7.0 c.c. per litre.

Near the shores each of the surfaces, such as isothermobaths, isohalines, isopycnals and those of the vertical distribution of gas, lies deeper than in the middle of the sea. This fact was observed in 1890-1891 also; most probably it is due to the dynamical influence of offshore winds, and of those of the opposite direction, which blow in the coastal parts of the sea, causing the water to descend, or to be raised, thus increasing the vertical convection.

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The Biological Conditions of the Black Sea observed in 1923-25.

THE observations in coastal waters, and also those made during the seasonal cruise and with the oceanographical expeditions in June-July 1924 and 1925 of the General Hydrographic Administration, lead to the following conclusions.

The Black Sea, from the oceanographical point of view, being formed of two sheets of water, namely, superficial layers of low salinity, and underlying water of great thickness and greater salinity, the conditions of life are determined by these conditions.

In the open sea the limit of life is found at the depth of 150-160 m. and sometimes at 125-110 m. Nearer the coasts this limit is deeper—sometimes about 200 m. The pelagic zooplankton is richer in the layers between the surface and 50 m. of depth; it is very uniform through the whole sea. From the depth of 50 m. to its inferior limit, the zooplankton is less rich. Near the shore it is more abundant, and in the middle of the sea its quantity varies greatly.

The seasonal variations of the zooplankton are very marked in the upper layers, and nearly disappear at the depth of 100 m.

The vertical distribution of the phytoplankton is under the control of some other causes as well as the temperature, such, for example, as the vertical distribution of light and some chemical components in the sea water, as also the hydrogen-ion concentration.

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The Line Fluorescence of Cadmium Vapour.

IN a previous communication (NATURE, August 1, p. 170) I gave a preliminary account of the study of the band fluorescence of cadmium vapour. In the further investigations leading to the results presented, special care has been given to the removal of possible impurities in cadmium vapour. In order to remove completely the gases adsorbed by the walls of the quartz bulbs in use, the bulb, joined to the pumps, was heated in an electric furnace to about 900° C. for

several days. The use of gas burners for heating the bulbs is not advisable, as at high temperatures the gases of the flame, first of all hydrogen, pass through the quartz wall and undoubtedly are occluded in it. Then, the bulbs being strongly heated when used, the gases may be liberated from the walls and pollute the vapour in question.

The mercury vapour was removed by the aid of a quartz mercury trap cooled in liquid air.

Pure cadmium previously three times distilled in vacuo was used. A few milligrams of it were distilled into the bulb, which was then placed in an electric furnace. The temperature being kept stationary, a beam of exciting light was projected through the bulb by the aid of a quartz lens. Attention was paid to its chromatic aberration, i.e. the position of the focus for the very short wave-lengths.

By increasing gradually the temperature, first traces of the fluorescence were observed at about 350° C. (pressure of cadmium vapour 0.2 mm.), a condensed spark with the electrodes of cadmium being used as a source of light. The intensity of the fluorescence increases rapidly with the increase of temperature; its colour, at first definitely bluish green, assumes gradually (at about 600° C.) the blue colour formerly described. The spectroscopic examination shows that the green colour is due to the intense emission of the first triplet of the principal series of the cadmium arc spectrum: 5086.06, 4800.09, 4678.37 Å.U. In the ultra-violet part of the spectrum, other lines were found in the fluorescence. In the subjoined table is given a list of these lines as they are observed at different temperatures.

Line Å U.	Series Notation.	Estimated Intensity						Remarks.
		220°	440°	550°	640°	750°	885°	
5086.1	2p ₁ -2s	0	0	2	2	2	2	Resonance line, (Triplet system) Resonance line (Singlet system)
4800.1	2p ₂ -2s	0	3	4	5	5	4	
4678.4	2p ₃ -2s	0	3	4	5	5	4	
3261.2	1S-2p ₂	2	4	6	5	4	3	
2288.8	1S-2P	3	4	0	0	0	0	

Remarks on the above table :

(1) Intensity 1 would denote a very faint line ; 6, a very intense one ; 0 denotes that the line in question was not visible at all.

(2) Intensity 0 of the line 5086 at 440°, and the small intensity at other temperatures, is due to the insensibility of the plates used for the blue-green light. Visually its intensity was not smaller than that of the line 4800.

It is also possible that the lines 2748.7 and 2573.1 Å.U. belonging to the spark spectrum of cadmium are present in the fluorescence at higher temperatures from about 750° C. They fall in a region of the very intense ultra-violet band fluorescence, so that it is very difficult to separate them from the continuous background and from the traces of the scattered exciting light.

It is interesting that the emission of the visible triplet and of the resonance line 3261.2 Å.U. of cadmium may take place also at the excitation over a *certain spectral range* by the emission lines of other elements, for example, of aluminium. Moreover, the intensity of the lines 5086, 4800 and 4678 excited by an aluminium spark is, other conditions remaining unchanged, much greater than when excited by a cadmium spark. Their intensity shows here also the maximum at about 750° C., whereas at higher temperatures (890° C.) it slightly diminishes. In the ultra-violet region only the presence of the resonance line 3261 was observed ;

its intensity reaches the maximum at about 600° ; then it diminishes, and at 890° it appears as a weak and diffuse line. This appearance may be due to the mutual influence of atoms, for example, the Stark effect, intense at these high temperatures because of the considerable density of vapour.

There appears also, with the excitation with the aluminium spark, as well as with the cadmium spark, the resonance line of mercury 2537 Å.U., which originates from the traces of mercury vapour present as impurity in the bulb.

The light of the copper spark excites also in the cadmium vapour the emission of the visible triplet (although much weaker than for the aluminium spark) and the emission of the resonance line 3261. The iron, lead and mercury spark excite the emission of the triplet mentioned as well.

These data would prove that the spectral extent of its excitation must be rather broad, and it lies probably for the most part below 2000 Å.U., where the aluminium spectrum possesses intense lines. On the other hand, lead does not possess any strong lines in the farther ultra-violet region. (below 2170 Å.U.), in spite of which it excites distinctly the emission of the visible triplet of cadmium. Therefore, the absorption must take place over all the wide spectral range.

It remains for the moment an open question, whether the deformations of the cadmium atom leading to the subsequent line emission are the direct result of the absorption of the radiating energy, or whether a number of intra-atomic and intra-molecular processes as well as collisions lead indirectly the atoms to the final excited state.

Impurities and small admixtures of other gases have a considerable, but not yet completely elucidated, influence on the emission of lines. The intensity of emission varies greatly with the bulb used. In a recently prepared bulb, which does not contain any traces of mercury vapour and from which the occluded gases were removed particularly thoroughly, the emission of the visible triplet takes

place at the excitation by the cadmium and aluminium spark only at about 700° C., and it is weaker than in the bulbs previously used. Also the visible band fluorescence is here much weaker, whereas the ultra-violet one is very intense. There may be, therefore, some connexion between the band fluorescence and the emission of lines

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October 20.

Weather Prediction from Observation of Cloudlets.

I FEAR Mr. Cave (NATURE, November 21, p. 749) misunderstands me, or I him. He controverts none of my facts, and his own are indisputable. Thus, though I, with amateurish powers of observation, find it difficult, no matter how long I watch, to perceive the waxing, and waning, of a cloud, I have always thought it probable that a thick or extensive mass, if exposed on opposite sides to unlike weather conditions (e.g. sun-heat), may condense at one extremity while dissolving at another. Also I know that the tendency is, on the whole, one way or the other. Again, I know that in our changeable climate, indeed in any climate, a waxing cloud does not necessarily imply rain ; it may not condense sufficiently. Nor does a waning cloud imply fine weather ; it may cease to wane. Nevertheless, "when clouds are seen wise men put on their cloaks," and exceptions do

not disprove the rule. They should merely direct attention to modifying circumstances—for example, to the variations of the barometer, the season of the year, the time of the day, the direction of the wind, and the colour of the sky. Whatever the modifying circumstances, it remains true that rain cannot come unless rainless clouds condense, or fine weather unless raining clouds dissolve. For most people, even I suppose for the weather expert, observation of this gathering, or breaking, of clouds is the most employed quick method of weather prediction.

It is usually impossible to base judgment on the behaviour of one cloud, or even of a few clouds. The bulk and opacity of these big masses renders observation of their changes difficult. Before we can be sure, each tends to drift out of sight, or be obscured by its fellows. Most of us, therefore, inspect the sky as a whole at intervals to ascertain whether it darkens or brightens. On the other hand, cloudlets—"the smallest and thinnest fragments of cloud that can be clearly isolated"—wax towards rain, or wane towards fine weather, with surprising swiftness. In my letter I wrote that five minutes' observation was usually sufficient. As a fact and as a rule, any one may satisfy himself within fifteen seconds. Cloudlets are small and diaphanous clouds which can be seen at the same time in every part. They do not fade at one extremity while developing at another. They are under the same atmospheric conditions as neighbouring clouds. If they change, their big neighbours are almost certainly changing in the same way. They furnish a quick and easy means of determining the atmospheric conditions not only at the moment, but also usually for hours to come. As compared to clouds, their changes are as easy to watch as the changes in a small smear of moisture compared to those in a cup of water.

That was all I wrote, or implied, in the letter (*NATURE*, November 7, p. 676) that Mr. Cave criticises. He writes, "I do not think that any of the explanations he gives accounts for the phenomenon." But I gave no explanations—unless the inference that changes in cloudlets are indices of changes in clouds be regarded as an explanation. It seems to me a truism. I stated easily verified facts—that and nothing more. "I do not think that the method . . . is at all of universal application." Of course it is not. No weather sign is. I mentioned some exceptions. He mentions another—that early on summer mornings cumuli sometimes wax and then wane without rain. But we have to deal with a rule, not with invariable succession. Moreover, the ordinary man, for whom I wrote, does not usually observe early on summer mornings. "The point is not to account for it, but to decide whether the waxing or waning of the cloudlets is to be taken account of in weather prediction." That certainly is the point. The test is most easy to apply. I think that even the expert will find it useful not only during all times of the day, but for more than the hundred days Mr. Cave mentions.

In this connexion, it is useful to discuss the origins of clouds and cloudlets. Now I really try to explain. How do clouds begin in the first instance? As new cloudlets? Or in a widespread and deepening mistiness? The first supposition seems to me improbable. It implies a sudden change in a minute portion of the drifting and mixing atmosphere. The second seems more likely and may, indeed, be often seen to be true, as when a misty sky gradually becomes grey, or when a ground fog develops. I suppose that the cumuli of which Mr. Cave writes are formed by the condensation of moisture as air rises to colder altitudes and there wane into cirro-cumuli. How do cloudlets originate? If *de novo*, then here again we have a sudden change in a minute portion of the atmosphere.

It seems more probable that they are either the last remains of clouds, or else portions of them which have become detached, not by being torn off by the winds (we rarely, if ever see that), but by the dissolving of connecting links (which we often see). So a puff of steam breaks into vanishing wisps. It follows that the mere presence of cloudlets is an index of clouds that have dissolved. Whether they are still dissolving can be determined by a moment's inspection.

May I direct attention to the fact that I have done no more than indicate an easily observed weather sign. I have not tried to minimise the value of any other sign. G. ARCHDALL REID.

Sulphur Treatment of Soil for Wart Disease.

In the *Annals of Applied Biology*, 12, 2, 1925, a paper was published by Roach, Glynne, Brierley and Crowther entitled "Experiments on the Control of Wart Diseases of Potatoes by Soil Treatment, with particular reference to the use of Sulphur." In 1922, treatment of a light soil at Ormskirk with sulphur had given promising results, whilst in 1924 the amount of disease was reduced from 73 per cent. in untreated soil to 8 per cent. with an incorporation of 10 cwt. of sulphur per acre, and to less than 4 per cent. with 20 cwt. sulphur per acre. On a heavy clay at Hatfield, clean plots were obtained with an application of 40 cwt. per acre.

During the past season a larger experiment has been carried out to test these results and the deductions drawn from them, and to determine whether the effect be a permanent one. As we have learned that experiments are being set up in other countries to test the efficacy of this sulphur treatment, it is desirable that the discrepant results obtained by us this season should be known so soon as possible. In our test at Ormskirk the following arrangement was adopted.

Plot.	Treatment.			
1	None.			
2	15	cwt. sulphur	per acre	in autumn.
3	10	"	"	"
4	{ 7½	"	"	"
	{ 7½	"	"	spring.
5	{ 5	"	"	autumn.
	{ 5	"	"	spring.
6	15	"	"	"
7	10	"	"	"
8	None			

In the untreated plots the plants grew well and were heavily warted. In the treated plots a first set of tubers planted in May and a second set planted in July almost entirely failed to grow. The surviving plants showed in all plots considerable amounts of wart disease although much less than in the control areas. At Hatfield two tons of sulphur per acre was applied: the crop was damaged and a considerable amount of wart disease was present.

Unavoidable differences in the conditions (seasonal, manurial, etc.) under which the work was carried out in 1924 and in 1925 suggest certain explanations of these results, but we are not in a position to say that any one of them is correct. The results already published are not of course invalidated, but it is clear that the sulphur treatment cannot, in the absence of further information on the soil and other factors involved, be regarded as a trustworthy method for freeing soil of the parasite causing wart disease. A more detailed account of our work will be published in the *Annals of Applied Biology*, 13, 2, 1926.

W. A. ROACH.

WM. B. BRIERLEY.

Rothamsted Experimental Station,
Harpenden, December 1.

The Occurrence of Dwi-manganese (At. No. 75) in Manganese Salts.

IN a letter to NATURE of November 28 bearing the above title, the authors, Messrs. Dolejšek and Heyrovský, deduce the existence of element 75 from measurements of the potential of a cathode immersed in saturated manganese sulphate solution. Their conclusion is supported by an examination of the X-ray spectrum, with which I have nothing to do. I do not think, however, that their deductions from the potential-current curves are necessarily valid. They find for the deposition potential of manganese -1.34 volt (abs.), a figure in substantial agreement with my own (*Trans. Faraday Soc.* (1924), 19, 559 and 20, 1). Below that potential they find two humps in what should normally be a very flat curve. The first and smaller hump they show to be due to some common impurity removable by hydrogen sulphide. The second, commencing at a voltage of -1.00 volt, they attribute to the discharge of the new element, dwi-manganese. I see no reason why this potential should not represent the potential of incipient hydrogen discharge: the actual deposition of manganese at -1.3 volt is accompanied by violent hydrogen discharge. Assuming their manganese sulphate solution to be neutral, the equilibrium potential of hydrogen should be about -0.13 volt, which requires an overvoltage of 0.87 volt, a readily realisable figure if the cathode were smooth platinum. The oscillatory nature of the potential curve in the neighbourhood of the manganese deposition potential may be due to the simultaneous discharge of hydrogen and manganese.

It would be interesting to know the form of the current-potential curve at the same cathode in an electrolyte containing no manganese, such as sodium sulphate. The effect of superposing an alternating current on the direct might also be tried. In this case, if the inflexion is due to hydrogen discharge it would be greatly displaced by the superposition; if to dwi-manganese, probably but little.

The authors then proceed to isolate a product presumably rich in dwi-manganese, which they dissolve in hydrochloric acid. They give no experimental details, but it is worthy of note that in the electrolysis of manganese chloride solutions, manganese tetrachloride is undoubtedly produced (*Trans. Chem. Soc.*, 1923, 123, 892), which hydrolyses with great readiness in the neighbourhood of the cathode, and might conceivably produce potential relationships of considerable complexity.

It is not my intention to impugn the substantial results of Messrs. Dolejšek and Heyrovský, except in so far as I think their interpretation of the inflexions of their curves is not necessarily correct

A. N. CAMPBELL.

Department of Chemistry,
University of Aberdeen.

Microseisms and the Indian Monsoon.

WITH reference to the note on the above subject in the report of the seismological committee of the British Association, Southampton, 1925, and my letter to NATURE, October 18, 1924, p. 576, it is perhaps worth while to place on record that the observations made during the current year fully confirmed the views regarding the appearance of microseisms of a certain type as a precursor of the monsoon.

This year the microseisms of the monsoon type could be detected in the seismograms on May 13. On May 15 very pronounced microseisms developed, and these lasted for the next two days. They were

apparently associated with a severe storm, which formed in the Bay of Bengal on May 12 and crossed the coast near Masulipatam on May 16. The storm caused strong winds in the south-east Arabian Sea and fairly widespread and locally heavy rain in the south of the Peninsula. With the dissipation of the storm the microseisms weakened, but they did not altogether disappear from the seismograms. During the last week of May, as the monsoon was being gradually established, they became more and more marked, and from the beginning of June onwards, so long as the monsoon conditions continued, their characteristic appearance day after day formed the most noticeable features in the seismograms. One could thus get very important indications regarding the advance of the monsoon in the south-east Arabian Sea long before it arrived on the west coast.

Following the discussion of Darwin on the variations in the vertical due to the elasticity of the earth's surface (Brit. Assoc. Report, 1882), a theory of the microseismic movements of the monsoon type has been worked out. This suggests that they are due to Rayleigh waves set up at the bottom of the sea by the train of water waves maintained by the monsoon currents. The periods of the movements, which vary from 5 to 9 seconds according to the strength of the wind, are correctly indicated by the theory. The complete paper on the subject will be published in due course.

S. K. BANERJI.

The Observatory, Bombay,
October 30.

Vitality of an Earwig.

AN earwig was found inside a high vacuum pumping set recently. How it managed to get there is not known, but it was possibly in the glass-blower's rubber tubing and was blown in when the apparatus was being modified a few hours previously.

The earwig was not observed until the pumps had been running a quarter of an hour, when it was seen crawling along the glass tubing. The pressure was about 0.001 mm.

In our efforts to extract the earwig it was rather roughly treated, as it fell into the mercury vapour pump (cold) and was eventually poured into a beaker with the mercury, being entirely submerged for a few seconds. It survived all this and actively crawled about on being released.

It is possibly well known that the skin and legs of this creature can withstand such knocking about, but it seems very remarkable that it could be active in a vacuum!

PHYSICIST

The Course of Instability of Elements.

URANIUM and thorium being the two amongst the old elements which are unstable, and being nearly at the end of the Periodic Table, is there any more reason to regard these as the last to remain unstable, than to regard them as the first to become unstable? If they represent the last to become unstable, we might suppose that all the other elements had passed through an unstable stage and in the course of ages to have become stable, thus throwing the greater part of the earth's history into the past, with less to come in the future. If, however, we suppose that only two elements have reached the unstable stage, all the remainder will have to come to this stage in turn, thus giving to the earth a tremendously long future as compared with that which is past.

EDWARD A. MARTIN.

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The Nature of Man's Structural Imperfections.¹

By Sir ARTHUR KEITH, F.R.S.

II.

DARWIN regarded the appendix as one of man's vestigial structures, and Metchnikoff accepted this verdict without demur, although there were then anatomists, particularly Prof. R. J. Berry,¹⁵ who refused to regard the appendix as a useless structure. Every child is born with a fully and well-developed appendix which varies in length round a mean of 35 mm. Ribbert's investigations¹⁶ showed that amongst the Swiss the appendix has reached its maximum length, 97 mm., by the twentieth year; thereafter the average length falls slowly, so that by the sixtieth year it has become reduced to 85 mm. Prof. Berry¹⁷ found in the population of Edinburgh that the appendix did not attain its full length, 89 mm., until the fortieth year, falling to 83 mm. by the sixtieth year. Drs. Garcia and Salloza¹⁸ measured the length of the appendix amongst Philipinos—a people living chiefly on a vegetarian dietary. By the twentieth year the appendix of this people had attained a length of 81 mm.; its maximum length, 96 mm., was not reached until the fiftieth year, while the average length fell to 82 mm. by the seventieth year. An organ which increases in length until the twentieth year, or even until the fiftieth, does not merit the name vestigial.

The size of the appendix at birth in the various forms of anthropoid apes we do not know, but in adult gorillas, chimpanzees, and orangs the appendix usually attains a length of 150 or 160 mm.—nearly double the length of the human appendix. In the most primitive form of anthropoid known to us, the gibbon, the appendix is most variable in length. In six animals which I dissected fresh from the jungle, all of them adult, the appendix varied in length from 75 mm. to 175 mm. In two of the animals, the cæcal contents were laden with numerous fruit stones as large as those of a cherry; the appendix in these two cases held a row of fruit stones, showing that it shared in the digestive work of the cæcum. There is no evidence to lead us to believe that anthropoid apes suffer from appendicitis in their natural habitat; they become subject to this disease when kept in confinement. Of 61 chimpanzees dying in captivity, 10 of them suffered from appendicitis.¹⁹ The evidence, such as it is, leads us to believe that when the appendix breaks down under the conditions of modern civilisation, it does so not because it is "vestigial," but because of its inability to withstand the conditions to which it is being exposed.

To express the real nature of the structural and functional imperfections seen in the human appendix, it is convenient to use a term coined by the late Sir William Gowers. He noted that in some families certain structures, such as the hair on the crown of the head, was apt to be shed as the result of a premature atrophy of the scalp. To such examples of

premature senility on the part of any organ or structure he applied the term *abiotrophy*.²⁰ In this sense the appendix is an abiotrophic structure, one which is apt to suffer from a disordered life-history; in a large proportions of Europeans it becomes atrophic or senile when other parts of the body are in full vigour. On the evidence collected by anatomists and pathologists, it is permissible to infer that if we could follow the life-histories of 1000 modern Europeans from birth to their seventieth year, the following would be the fate of their appendices. By the end of the tenth year the lumen of this structure would be partially or completely obliterated in 40 of them; by the twentieth year the same fate would have overtaken 70 more; by the thirtieth year 60 others would have been added to the list; by the fortieth year 80 further cases of obliteration would have occurred; by the sixtieth year there would be 110 additional cases. Of the thousand people who reached the age of seventy, only 500 of them would retain their appendix in an unblemished functional state; in the other 500 the appendix would have undergone a premature atrophy at succeeding stages in the journey through life. In this the appendix keeps company with all structures which are of a lymphoidal nature. The tonsils, the thymus, lymphatic glands, and Peyer's patches have similar life-histories, but no one would describe them as vestiges or rudiments. There is much in the name we apply to structures; when we name them "vestigial," "congenital," or "useless," we shut the door on all further inquiry. As Paley declared a century ago, our list of "useless" structures decreases as our stock of knowledge increases.

The eye, which is man's chief organ of sense, has, under the stress of civilisation, become the subject of a wrong growth or abiotrophy. If we take a thousand men or women over the age of twenty-five years, we shall find that about 150 of them suffer from a degree of myopia which prevents them from seeing distant objects clearly; and yet in all of them, just as was the case of the appendix, the eye was normal at birth. The incidence of the disorder is somewhat similar to that of the appendix; it appears during the period in which the eye is undergrowing growth—a process of the most complex kind²¹; in a few, myopic changes appear by the fifth year, the highest rate of incidence taking place as puberty is reached and passed. We cannot believe that among our hunting ancestors, for whom distant sight was so vital, that every seventh man was myopic.

Myopia we must regard as a structural disharmony occasioned by the conditions which civilisation has entailed on us. Short sight, as Dr. John Kirk has stated,²² is certainly a disorder of growth, and the essential problem is to discover not why 15 per cent. of our population suffers from it, but why it does not occur in the remaining 85 per cent. Children may be fed on the same food and undergo the same school

¹ Continued from p. 823.¹⁵ *Anat. Anz.*, 1895, vol. 10, p. 761; *Journ. Anat. and Physiol.*, 1906, vol. 40, p. 247.¹⁶ Prof. Ribbert, *Virchow's Archives*, 1893, vol. 132, p. 66.¹⁷ Prof. R. J. Berry, *Anat. Anz.*, 1895, vol. 10.¹⁸ Garcia and Salloza, *Philippine Journal of Science*, 1921, vol. 18, p. 707. See also Fawcett and Blackford, *Journ. Anat. and Physiol.*, 1900, vol. 34, p. xxi; S. Rutherford Macphail, *ibid.*, 1917, vol. 51, p. 306.¹⁹ Weinberg, *Bull. de la Soc. de Path.*, 1908, vol. 1, p. 556.²⁰ The reader will see later that I use this term in a somewhat wider sense—one which includes irregular as well as reduced growth.²¹ I have dealt with the incidence and nature of myopia in the *British Journal of Physiological Optics*, 1925, vol. 1, p. 369.²² *Brit. Med. Journ.*, 1921, vol. 2, p. 8.

tasks, yet only in certain individuals does the eyeball undergo abnormal elongation. They only are affected by modern conditions, the others are not.

Perhaps no structure in the human body illustrates abiotrophic changes so well as the lens of the eye. By the age of forty-five the elasticity of the lens has become so reduced in most of us that we have to seek the aid of spectacles. Some time ago Dr. Ernest Clarke²³ examined the eyes of 1200 people of all ages, and charted in graphic form the condition of the lens. From that chart we can see that some individuals at the age of forty-five retain the elasticity of lens which is normal at thirty-five years of age, while others have reached a stage usually found in men and women of sixty. It is with the lens of the eye as with the appendix, abiotrophy sets in prematurely in some; in others the change is delayed.

The consideration of the functional failure of the lens of the eye brings us to a problem which fascinated Metchnikoff. What is the term of life which is natural to man? Metchnikoff inclined to place it at a hundred years—that if we escaped accident and disease the inherent vitality of our tissues was sufficient to make a centenarian of every one. At the age of forty-five the lens of the normal man is already old; it has reached the term of its full utility. We have no reason to suppose that civilisation has shortened or is shortening its period of usefulness. The indication it affords supports the belief that Nature has worked out the evolution of the human family on a mean life tenure of forty-five years; she has hitherto run the human army on a short-service system. Unfortunately we have no vital statistics of our nearest allies, the anthropoid apes. Micky, a chimpanzee which died lately in the Zoological Gardens of London, lived there for twenty-six years, and was three or four years of age when he arrived. Thirty years ago I made an intensive study on the age changes of the teeth and skulls of the great anthropoid apes and came to the conclusion that very few of them reached the fifth decade of life. All the elastic tissue and cartilage of the body keep the lens company in their rate of aging; they lose their resiliency by the middle of the fifth decade. The age of forty-five years sees the end of the term of child-bearing which is normal for women. When we consult the rates of mortality which now prevail we find that a sudden rise sets in during the fifth decade, and this rise assumes a steeper and steeper gradient with every subsequent decade. All of these facts seem to show that forty-five years was the span allotted to man when he was the blind slave of Nature. Civilisation now permits many men and women to live the span of two such lives, but whether it would be an advantage for civilisation that all should live to be centenarians, as Metchnikoff believed, is a moot point. We must take civilisation in the round; if it has searched out the weak points in our inherited organisation, it has also added incalculably to the span and comfort of life.

All the structural imperfections of man's body which have been discussed up to this point are of a kind which perish in the grave. We have no means of telling whether or not our remote ancestors suffered from appendicitis or were the victims of myopia. Fortunately, from this point of view, there are certain

of the durable parts of man's body which manifest abiotrophic changes—the teeth and jaws. During the last twenty years I have had an opportunity of examining the facial parts of more than three hundred individuals who lived in England more than a thousand years ago, some of them so much as eight or ten thousand years ago. Seven years ago I made an elaborate comparison between fifty of these ancient skulls—twenty-five of which were adjudged to be those of men and twenty-five of women, with equal numbers of individuals who had lived in England within the last two centuries.²⁴ In only three of the fifty ancient skulls did the upper and lower teeth fail to meet in an edge-to-edge bite; in all of the fifty modern skulls the bite was of the overlapping or scissors type. Our teeth are in an abiotrophic state; the failure of the wisdom teeth or third molars to form, or to erupt if they are formed, is but one symptom of this abiotrophic change; it affects crown, cusp, and root development. In the fifty ancient skulls, instead of 100 upper wisdom teeth, there were only 82, 13 being absent from non-development and 5 from non-eruption. In the fifty modern skulls, instead of 100 upper wisdom teeth, there were only 59; 30 of these were absent from non-development, 11 from non-eruption.

Such evidence shows that although abiotrophic changes had overtaken the dental system of the western European as early as the Neolithic period, yet these changes have been accelerated during the more recent centuries. Dental abscesses were nearly as common in the ancient skulls as in the modern; carious teeth, on the other hand, were three times more frequent in modern skulls than in the ancient. The researches of the Mellanbys²⁵ have proved that the quality of enamel and of dentine, particularly of secondary dentine, has a relation to the vitamin content of a dietary. Equally important for the proper formation of teeth, as McCollum and his colleagues²⁶ have demonstrated, is the presence in food of a due proportion of certain mineral salts. Nevertheless, although a school of children are exposed equally to unfavourable conditions, it is only in a certain number that dental defects will occur; in this respect the dental system behaves as do all structures which are liable to abiotrophic changes.

In not one of the fifty ancient skulls was the palate contracted, whereas of the fifty modern skulls there were thirteen in which this condition was present to a recognisable degree—in more than half of them to a marked extent. No matter which stratum of our population we make observations on, we shall find that every fourth or fifth child or adult we examine possesses a palate which, compared with the older type, may be described as both altered in form and reduced in size. I have never seen this defect and irregularity of palatal growth except in skulls from cemeteries of the eighteenth and nineteenth centuries. It may be thought that this irregular growth with reduction in the size of palate, and the defects in the formation of the jaws and face which usually accompany them, are merely the results of the soft and highly prepared kinds

²⁴ Some of the details of this comparison were published in "Five Lectures," issued by the Dental Board of the United Kingdom, 1924.

²⁵ Dr. E. Mellanby, *Brit. Med. Journ.*, 1912, vol. 1, p. 831; Dr. May Mellanby, *ibid.*, 1924, vol. 2, p. 354.

²⁶ *Johns Hopkins Hospital Bulletin*, 1922, vol. 33, p. 202.

²³ *NATURE*, 1916, vol. 97, p. 554.

of food we eat; with such a dietary the teeth, jaws, and chewing muscles are deprived of the work which fell to them in more primitive times. That this is not the true explanation is proved by this fact. When children are fed, clothed, and exercised exactly alike, all are not affected; only some of them develop irregularities of the palate and jaws. There is a special susceptibility to these imperfections in certain races and in certain families.

Amongst modern British people are to be seen various facial characters, particularly in the orbits, in the cheek bones, and in the bony supports of the nose, which are never to be noted in the facial framework of people who lived in Britain during the pre-Norman period. When a Continental cartoonist seeks to represent John Bull he always emphasises these new facial characteristics. Such changes in the form of the facial bones, like contraction of the palate, which they usually accompany, are not the result of a nasal obstruction such as might be caused by enlarged adenoids or tonsils; the cause lies deeper. The incidence of irregularities in the growth of the face follow the same laws as hold for all abiotrophic structures such as the appendix, the sclerotic coat of the eye, the thymus, and the tonsil. Further research will likely prove that the disorders of growth which overtake all these structures are linked to a disturbed action of lymphocytes and of all the constituent elements of the lymphoid tissues. Dr. W. Cramer has become convinced that lymphocytes are actively concerned in assimilation of food and in the nutrition of tissues, and that the nature of the dietary does directly affect their activities. It seems to me very probable that a fuller knowledge of the life-histories of lymphocytes, particularly of the office they perform in growing tissues, will go far to explain the disharmonies which civilisation is producing in the bodies of some of us. But the problem of explaining why some members of our community are highly susceptible to these new conditions, while others are less so, and why the majority remain unaffected, will still remain.

I have touched only the fringe of a great subject; I have left undiscussed the numerous imperfections and disharmonies which civilisation has made manifest in

structures concerned in the maintenance of posture,²⁷ and in those which are concerned with the circulation of blood and with the duties of respiration. I have said enough, I believe, to show that Metchnikoff was right when he declared that civilisation had launched man on a great experiment. From this experiment there is no turning back. We cannot return to the conditions of human life which prevailed in Britain 6000 years ago; there are more people in one of the lesser back streets of London than could find an existence in the whole length and breadth of the Thames valley if we were to resume the manner of living of our distant ancestors. We cannot go back; we must go on. Seeing how differently we are now circumstanced in every relationship of life—in food, in drink, in shelter, in warmth, in occupation, and in amusement—the wonder is, not that structural imperfections and functional disharmonies should develop in a proportion of our numbers, but that so many of us should escape harm altogether and enjoy good health. It says much for the adaptational reaction which is inherent to the human body that it withstands the artificial conditions of modern civilisation so well as it does.

How are our bodies to be protected against these ills with which civilisation threatens them? Metchnikoff, a declared and open rebel against Nature, hoped that science might discover some short-cut for man's escape, some way of speeding up the evolutionary machinery of his body and so making it perfectly fitted for the life which ever-advancing civilisation is forcing on mankind. I also believe that science will find a means of escape, but not by Metchnikoff's way. The solution of our problem is a fuller knowledge of the use and working of those parts of our bodies which are most apt to give way under our modern manner of living—the use of such structures as the great bowel. When we have replaced our ignorance by real knowledge we shall then be in a position, not to adapt our bodily structures to our mode of living, but our mode of living to our bodily structures. This seems to me the best way out.

²⁷ I have discussed the "Imperfections of Man's Postural Structures" in the *Brit. Med. Journ.*, 1923, vol. 1. pp. 451, 493, 545, 587, 642, 669.

Hypothesis about Push or Contact Force.¹

By Sir OLIVER LODGE, F.R.S.

ONE of the remarkable discoveries of our times has been the pressure of radiation. Though this pressure is ordinarily so extremely minute that it was difficult to discover—and perhaps would not have been discovered had it not been predicted mathematically beforehand by Clerk Maxwell—yet in certain circumstances the pressure of light can be very large and of cosmic importance. Whether it has an influence and ought to be taken into account in the intimate structure of atoms, I am not prepared to say, but I suggest it. The Boscovich contemplation of regions where force changes sign, and our whole knowledge of the stability of Bohr's atomic orbits, represent facts which have not yet been accounted for.

¹ From the first Norman Lockyer Lecture, "On the Link between Matter and Matter," delivered to the British Science Guild in the Goldsmiths' Hall, E.C., on November 16.

Moreover, I am going to suggest that the pressure of light may have to be taken into account before the most ordinary operations of daily life, even the propulsion of a wheelbarrow, are properly explained. The force of ether-waves may encroach on the region of mechanism, and be needed for a fuller interpretation of the familiar mechanical force exerted by one body in contact with another. When denying action at a distance we must not slur over a difficulty by pleading that the distance is small.

It may seem absurd to demand a theory of the manner in which one piece of matter pushes another. Even if one denies actual contact between atoms, it is reasonable to think of each atom as so surrounded by planetary electrons as to oppose similar electrifications to each other, and thus account statically for the repulsive

force. But the electrons are in motion, and that suggests further non-static possibilities. Moreover, one effect of close approach is attraction followed by cohesion, if the approach is close enough—the atoms themselves, being charged, naturally arrange themselves for some collateral mutual attraction—a sort of residual affinity between the molecules. Why should there be repulsion instead of attraction at a certain distance?

The one thing that always gives repulsion without reference to sign of charge is radiation. Can any of this repulsion be due to radiation pressure? The idea is not to be turned down off-hand without consideration, unlikely as it may appear at first. The alternations of attraction and repulsion, at different distances apart, have to be accounted for somehow.

The pressure of radiation is proportional to the energy in unit volume, and in the case of heat radiation depends on the fourth power of the temperature, which again is proportional to the square of the atomic speed. The speed associated with any given temperature is not great; for example, the speed of helium atoms at ordinary temperature is reckoned by Eddington at 1 mile a second, and at 4 million degrees is still only 100 miles a second. The speed of electrons at the same temperature would be 40 times greater, but even that is not quick for an electron. They may be moving at anything up to 100,000 miles a second in an atom. But they are moving regularly; and regular motion is not temperature: temperature requires irregular motion. Well, my point is that the mutual perturbation of approaching atoms may cause the necessary irregularity, and that the radiation thus caused, at really close quarters, may be very intense.

We know that radiation is emitted or absorbed whenever an electron jumps from orbit to orbit. I picture the electrons of closely juxtaposed atoms as jumping up and down, like caged birds, from perch to perch. Each bird jumping up consumes energy, each bird jumping down restores it. No matter whether radiation is emitted or absorbed, the result is still repulsion. At each jump a quantum is emitted, and at very high frequencies the quantum is by no means negligible. The temperature comparable to a thirtieth of the speed of light is some thousands of millions of degrees, and the energy and pressure of radiation corresponding to that temperature are enormous; quite enough to account for any mechanical force.

Between the contiguous surfaces I picture radiation going and coming, emitted and absorbed, continually. There is no loss of energy, the radiation does not escape, but it can be very intense and can produce an enormous pressure, as it does in the interior of stars.

I spoke of the orbital electrons being perturbed by proximity, but they cannot be perturbed infinitesimally. Nothing short of a quantum of disturbance is effective. An orbital electron will not yield to any inferior disturbance; it cannot respond slightly, it responds by a jump or not at all. It is apparently under some constraint to remain in a stable orbit, until it can jump out; and if it jumps, it either emits or absorbs radiation. The quantised orbits are not susceptible to continuous perturbation: every occurrence in an atom is discontinuous. The frequency of the radiation, and

therefore the energy of the quantum, will be determined by the speed-energy-difference between the orbits.

What reason is there to suppose that proximity would introduce perturbation of any kind? Well, in inverse square orbits, equilibrium is only preserved by a certain tangential velocity. Any sluggishness or retarding force causes a projectile to drop in; any tendency to increase the speed makes it move farther away. The law of conservation of areas will no longer be obeyed when a repulsive force is applied in the plane of the orbit. On one side the particle will be accelerated, on the other retarded. Ordinarily, revolution of the apses would occur. But this may become too violent to be thus conveniently described, and it is doubtful how much ordinary perturbations are permissible in the very peculiar stable orbits of Bohr. In a quantised orbit the above sort of influence must at some stage of violence lead to a jump. A jump cannot leave the particle's energy as it was: it gains too much by a fall, some must be emitted.

That is my present idea of the force which keeps bodies apart and enables one to push another.

Parenthetically we may observe that in massive atoms the inner electronic speed is very great, and so, from these, extremely high radiation may perhaps escape, and may stimulate spontaneous radioactivity in other atoms, by getting down to and ejecting some of the deep-seated nuclear electrons. If two of those go away, an alpha particle is likely to be driven out violently by electrical repulsion.

The state of matter in or near a nucleus may be comparable to the state inside a star like the companion of Sirius, except that gravitation is inoperative. The close-packed density is prodigious.

These ideas are crude, granted; but a working hypothesis is a thing to be worked, its consequences to be traced, and then either improved or discarded. Anyhow our aim ought to be to explain those facts on dynamical principles, perhaps not the ordinary dynamics, but etherial dynamics, and that is far from having been worked out; perhaps it cannot be said to have been begun.

Already some attempt has been made to assimilate radiation with matter by the unlikely path of thermodynamics. Radiation has been used as the working substance in a theoretical heat engine. Its pressure has thus been mechanically employed. It has been dealt with almost like a gas. The laws of gases—the statistical behaviour of discontinuous random particles—have been applied to electricity, and even to radiation. By this means not only can the known law of Stefan, connecting *total* radiation with temperature, be deduced, but also a law regulating the distribution of energy among different wave-lengths has been formulated by the genius of Wien: which formulation, though it is not yet fully explained, is nevertheless true. The average energy associated with any particular wave-length must be equal to some function of the product of wave-length and absolute temperature, divided by the fifth power of the wave-length. That is Wien's law. This law involves an unknown function, as well as the curious idea of the temperature of space or of radiation; for it deals with the waves statistically, after the manner of the kinetic theory of gases. The flying about of the radiation inside a completely

reflecting enclosure has a complete irregularity, which justifies the application of the term "temperature" to the energy therein contained.

As for the unknown function—the discovery of that was elucidated by Rayleigh, and completed by Planck; and it is there that the "quantum" made its appearance. For if the energy could be absorbed or emitted continuously, all the energy of matter would go into the ether, and the universe would fade away and die, or at least would cease to be active. The effect of dis-

continuous emission and absorption saves the universe from destruction, and makes this lively planet possible. If radiation could go on from atoms continuously, all the energy would get into the ether: matter would have none, and none of us would exist.

These discoveries have no human significance, people think. They are chock-full of significance. We are down among the foundation-stones of reality, the laws which make activity possible, the laws which perpetuate the atoms of which our own bodies are composed.

Scientific and Industrial Research in 1924-25.¹

THE latest report issued by the Department of Scientific and Industrial Research consists, as usual, of a short summary report by the Committee of the Privy Council, a long report by the Advisory Council, a summary of the work done by research institutions directly under the Department, numerous appendices, and a good index. In the first report the view is expressed that the embarrassments and losses which British staple industries are suffering do not arise primarily from the neglect of science, although in many cases delay in recovery is caused by lack of scientific leadership. The successful application of scientific discoveries to industry is a slow and expensive business, as witness the delay of two generations in applying Faraday's work on electro-magnetism, and the interval of twenty years which elapsed between the discovery of artificial indigo and its successful exploitation at a cost of 1,000,000*l.* The Fuel Research Station is apparently following these precedents, for in spite of an expenditure of more than 400,000*l.* in seven years, it has found no solution of the problem of producing smokeless fuel at an economic cost. It is, however, stated that the work has produced profits and economies in other directions which exceed in monetary value the total expenditure on fuel research. Attempts to manufacture power alcohol from beets, mangolds, and Jerusalem artichokes have also proved abortive, although the last-named are still being cultivated in various localities for use in future tests.

The Food Investigation Board has devoted most of its attention to the handling and preservation of food in order to reduce loss and to increase supplies. The problem of the freezing of beef has been attacked from the point of view of the freezing of colloids, and it has been found that if a mass of colloid, *e.g.* a disc of jelly, be frozen slowly, ice forms on the external surface, whereas if the rate of freezing be high, congelation takes place within the mass. When eggs are preserved by cold, protein is thrown out of solution and is not redissolved on thawing. In the living organism highly insoluble substances are often held in solution by other substances, and freezing apparently renders them permanently insoluble. Changes undergone by fruit and vegetables during storage and transport are still under investigation, but the work on fish preservation has been held up owing to the impossibility of conducting experiments at an inland station. Many problems connected with cold storage are being studied at the National Physical Laboratory, such as the inflammability of heat-insulating materials, the physical

properties of refrigerants, hygrometry, rate of flow of fluid in the circuit of a refrigeration plant; and on the chemical side, work is being continued on the higher unsaturated fatty acids, glycogen, and the formation of fat by yeast.

The Geological Survey has surveyed the coalfields and adjacent areas, investigated mineral deposits, water-supplies, and examined rocks and soils exposed during the construction of new roads. The Museum of Practical Geology and the Geological Survey are to be permanently housed in buildings to be erected adjoining the Natural History and Science Museums at South Kensington. A site has been acquired at Princes Risborough for the Forest Products Laboratory, but for the next two years work will be continued at the Royal Aircraft Establishment in Hampshire. Investigations in progress include the cause of brittleness in timbers, preservatives for wood other than creosote, and the improvement of kiln-drying practice.

Building research is assuming greater importance owing to the serious housing situation, and so a new and larger research station is about to be opened at Watford. The fundamental problems that are being attacked, under the advice of four expert committees, include: (1) architectural acoustics, moisture-condensation on internal wall-coverings, and the rate of transmission of moisture through building materials; (2) setting and hardening of cements, including non-corrosive oxychloride flooring materials, and changes in volume of building materials due to moisture changes; (3) preservation of stonework, and attempts to express "weathering" in terms of temperature and moisture variations; (4) wind-pressure on roofs, bridges, etc., vibration due to machinery, or road and rail traffic, permeability of concrete and its movements due to moisture and temperature changes, standardisation of tests for compression, abrasion, and hardness. Some of these investigations are already yielding results of immediate practical importance.

The work of the National Physical Laboratory (N.P.L.) is so vast and diverse that reference can only be made here to some of the investigations in pure science which it has undertaken recently, namely, calorimetry at high temperatures, the magnetic properties of iron and other alloys, properties of dielectrics, the vertical-force magnetometer, the efficiency of power transmission by gears, ferrous alloys free from carbon, and methods of spectrographic analysis of metals and alloys.

Important duties are also carried out by the various co-ordinating research boards. In chemistry, the commercial production of formaldehyde as a cheap

¹ Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1924-25. Pp. 155. Cmd. 2491. London: H.M. Stationery Office. Price 3*s.* net.

disinfectant for wool has been investigated, but owing to the cost of concentrating the dilute solutions obtained, success appears improbable. The production of carbon tetrachloride on a large scale, the corrosion of metals, accumulators, and containers for liquid oxygen, have been studied experimentally, but work generally has been impeded by the lack of adequate laboratory accommodation. More rapid progress can now be anticipated in view of the completion of the new chemical laboratory at Teddington, where special attention will be given to the study of chemical reactions under high pressures. The Engineering Co-ordinating Board has dealt with researches recommended by the Aeronautical Research Committee, such as light alloys, fatigue of materials, elasticity of steel strip, strength and properties of materials at high temperatures, prevention of rust, and tests for motor tyres. Among the researches undertaken in physics are: the silencing of aeroplanes, a high-power source of sound, acoustical properties of building materials, elasticity of aircraft materials, yellow glass for railway and aircraft lights, standardisation methods for the specification of colour, and the general nature of phosphorescence.

The gross expenditure on the various programmes of research was 303,070*l.*, of which 50,471*l.* was incurred for fuel research, 22,927*l.* for engineering, 17,571*l.* for food investigation, 14,529*l.* for chemistry, 13,948*l.* for radio, 11,940*l.* for building research, and 140,138*l.* for research and standardisation at the National Physical Laboratory. In all, 173,455*l.* was expended on the N.P.L., but nearly one-half of this sum was recovered in fees for tests and special investigations made for outside bodies.

The number of research associations in being during 1924-25 was twenty-five, of which twenty-one were in active operation. The Glass Research Association and the British Portland Cement Research Association have been liquidated, and the future of the Scottish Shale Oil Research Association appears doubtful. Research on glass will for the present be continued at the N.P.L., by the British Scientific Instruments Research Association, and in the Department of Glass Technology of the University of Sheffield. It is anticipated that a research association for food manufacturers will be launched shortly. Several associations appear to be in financial low water, and have needed the assistance of increased or extended grants; on the other hand, no payment was made to the British Iron Manufacturers' Association (which is temporarily suspended), or to the newly formed British Colliery Owners' Research Association.

The total disbursement on grants was 100,118*l.*, and the unexpended balance of the Million Fund was 518,200*l.* Average grants made to some of these associations during their existence—ranging from two to seven years—have been as follows: glass, 11,720*l.*; electrical and allied industries, 9552*l.*; cotton industry, 9819*l.*; scientific instruments, 9212*l.*; linen industry, 7510*l.*; portland cement, 4418*l.*; Scottish shale oil, 1500*l.*; rubber and tyre manufacturers, 5061*l.*; non-ferrous metals, 4070*l.*; boot, shoe, and allied trades, 797*l.* The total expenditure on the 258 grants made to individual research workers and students in training was 35,000*l.*; and the cost of administration at headquarters was 35,920*l.*, or about 6.5 per cent. of the total expenditure of the Department (539,199*l.*).

Obituary.

PROF. J. N. LANGLEY, F.R.S.

"YOU will always find it easy to generalise so long as you are content not to inquire too closely into detail." In these words, or words rather like them, Langley once expressed something which was very near to being the pivot of his intellectual outlook. The occasion was somewhere about the summer of 1900, when he was working at the properties of adrenalin, and discussing whether it could or could not be regarded as a general stimulant of the nerve-endings of the sympathetic system.

He came into the old physiological library at Cambridge, Foster's old room, from his operating room next door, to snatch a couple of rolls and a glass of milk. These formed the standard laboratory lunch of those days, and Langley would fall to talking about his work. Having finished his lunch he would return and perhaps operate until four or five in the afternoon, having started at about half-past ten. When he was conducting a research he would work in this way at high pressure for days on end, carrying through a long and exacting experiment each day, his marvellous skill as an operator making it possible for the animal which he was studying to remain in good condition for a very long time. When his experiments on a particular point were finished, he would absent himself from the laboratory until the paper was written—I am now speaking of the days before he was professor; when it had gone to press he would take up the next point. He was essentially a

worker who did one thing at a time and developed his thesis, or allowed his thesis to develop itself point by point.

Langley was never content not to look too closely into detail. "The exception which proved the rule" had no meaning for him. It just upset the rule, and Langley was always more content to remain ignorant of "the rule" than to compromise in the slightest degree with the detailed statement of facts. His attitude was possibly born of his experience in making his survey of the autonomic system. That was his great work, and alone it would have formed a sufficient basis for his equally great reputation. Whether or not it was a feat of anatomy rather than of physiology is a matter which might provoke discussion. I have thought at times that had Langley labelled himself as an anatomist he would have been accorded an outstanding position in that subject. It would have been difficult for him to adopt that label, for he was not a qualified medical man, and indeed I suppose he was one of the first men who were pre-eminent in physiology without being medical practitioners. As time has passed, Langley's example has been followed by many another, and I imagine that as chemistry plays an increasing rôle in physiology, an increasing number of physiologists will be "unqualified."

To return, however, to the autonomic system; the methods by which Langley explored it were partly physiological and partly anatomical. On the physio-

logical—or perhaps even the pharmacological side—he discovered that nicotine abolished the conductivity of a synapse. This discovery provided a method for the charting of all stations throughout the autonomic system. One such still bears his name—Langley's ganglion in the submaxillary gland. Also, of course, much of his routine consisted in the stimulation of nerve-trunks with the object of ascertaining what response was produced in the peripheral endings attached to them. But a great deal of the method was frankly anatomical. It consisted in cutting a nerve-trunk and seeking out through the innumerable ramifications of the sympathetic system the destination of all the cut fibres. These might amount to hundreds or even thousands. The cut fibres were allowed to degenerate and so could be recognised from their sound fellows by their histological appearance. When the fibres had degenerated the animal was killed, all the peripheral nerves involved were examined, and the sound fibres were separated from the degenerate ones and the latter were teased out into rows under the microscope and counted.

It is not very easy to appraise the value of Langley as a lecturer; in my student days he did not give elementary lectures; therefore I can only speak of his advanced lectures at first hand. My memory of these is that they were mines of information, and the notes which I took from them were of the utmost use to me in subsequent teaching. But I remember also that to get a clear idea of the lectures required very close attention on the part of the student. Langley's method was to pass from one subject to another by a very gentle gradation rather than by an abrupt change; so gradual indeed was the passage that unless the student was attending pretty closely he ran the chance of missing it altogether. If that happened—if, for example, you thought he was still lecturing about the spleen when he had really passed to the thymus—it was not very easy to pick up the threads. This habit, which provided an occasional stumbling-block to advanced men, presented, I imagine, much more difficulty to a class more ignorant and less able to concentrate. At all events it is certain that different persons derived very different amounts of benefit from his elementary course. No one, however, regarded the lectures as in any way trivial, or Langley as anything but the great physiologist which he was. It was a matter of conscience with him to demonstrate in person throughout the whole of every practical class in histology, and also many of those in the "machine room," his object being to get to know each man individually in so far as that object could be attained.

Langley was seventy-three years of age at the time of his death on November 5. He and Sir Edward Sharpey-Schafer formed the remaining two of a generation of experimenters which really placed British physiology in the position which it now occupies. That position has been amply sustained by a brilliant group of men ten years or so their juniors. Langley's whole life as a physiologist was spent in Cambridge, excepting a short time after the taking of his degree when he worked in Heidenhain's laboratory. It was there, I think, that his interest in the salivary and other secreting glands commenced. That interest, by a gradual transition, led to an investigation of the nerves

which operated them. Those were days of antagonistic nerves; the salivary glands provided an outstanding example of their action, and it was not unnatural to hope that if the action of the chorda tympani and the sympathetic respectively on the protoplasm of the submaxillary gland was understood, a great stride would have been achieved towards the comprehension of living processes in general. It was not to be. Nearly fifty years have passed; much work has been done (the most recent being that of Anrep and Harris), and the submaxillary gland now appears rather the example of an anomalous meeting-place of the cutaneous and internal innervations than the *venue* of a typical process of life. Langley, I think, saw this. At any rate, he forsook the study of its cells and was led by that of its nervous supply to the investigation of the autonomic system as a whole.

In Cambridge, Langley took an active part in the organisation of the scientific side of things. He was chairman, at the time of his death, of the Special Board of Biology and Geology, and at an earlier period he served a term in the Council of the Senate. Langley's "distinctions" were so numerous as to make their mere recital tedious; they occupy about a dozen lines of small print in the year book of the Royal Society. Probably there was none that he valued more than the Royal Medal of the Royal Society itself.

The above account of Langley has of necessity dealt chiefly with his scientific work. It would be incomplete without emphasising the fact that, scientist as he was, he was singularly many-sided and the very antithesis of the stage professor. Excellent company, whether as a host or as a guest, and fond of outdoor exercise of many kinds, he excelled as a skater. At one time it was his custom to go to Switzerland for the winter, and in the early 'nineties possibly there were not a dozen such good skaters as he in England.

Langley has left two material monuments, the *Journal of Physiology* and the Cambridge Physiological Laboratory. Of the former he became owner and editor. By universal consent there is no better journal; it was rigorously edited, papers were ruthlessly pruned of anything which was redundant or confusing—"woolly," as Langley used to say. Yet as an editor Langley had a wonderful sense for the important, and, severe as was his critical faculty, he had a generous appreciation of any grains of real merit in a man's work. The Physiological Laboratory at Cambridge is no less the product of his power of minute organisation. He, aided by Dr. (now Sir Walter) Fletcher, set himself the task of producing a laboratory which should be adapted, down to the minutest details, for the very various kinds of work which went on in Cambridge at that time, the work of Gaskell, of Anderson, of Hardy, of Mines, of Fletcher, of Keith Lucas, of Rivers, of Hopkins,¹ of Hill, and of quite a number of others. Greater than any material monument, however, is that of the school of workers over which he presided.

J. BARCROFT.

PROF. A. V. HILL writes: "Attention has been directed recently in the Press to the faculty of prophecy which—within limits—mankind possesses. The

¹ The physiological laboratory as originally designed included a wing for biochemistry.

following letter sent to me just sixteen years ago (Nov. 11, 1909) by my late friend and master, Prof. J. N. Langley, is an example of those qualities of scientific judgment which, on occasion, enable men of rare intellect and knowledge to predict the future. In view of what has happened since he wrote, in the scientific study of muscle, physiologists will appreciate the accuracy and insight of Prof. Langley's forecast and advice; and they may be glad to read, as a tribute to his scientific memory, the words which he himself wrote in 1909."

HEDGERLEY LODGE,
CAMBRIDGE,
Nov. 11, 1909.

MY DEAR HILL—I have been thinking over the question of what piece of work it would be best for you to undertake. I am inclined to think that you might settle down to investigate the variation in the efficiency of the cut-out frog's muscle as a thermodynamic machine. A good many years ago Heidenhain and Fick worked at this, but there is an especial problem suggested by Fletcher and Hopkins' work, as to the efficiency of the muscle working with and without oxygen, which I don't think has been touched. Once started there are plenty of further experiments to do, and the question is a very important one for muscle physiology. . . . I have, I think, Blix' apparatus in the Laboratory [he had bought it some time before as a speculation for some future pupil] which he stated to be delicate enough to show the heat developed in frog's muscle by a single muscle contraction, and we can get any other apparatus you want.

So think it over. I enclose a couple of pages showing some of the bearings of the problem.—Yours sincerely,
J. N. LANGLEY.

MR. THOMAS CASE.

MORE than one branch of learning is the poorer for the death of Thomas Case, late president of Corpus Christi College, and sometime professor of moral and metaphysical philosophy at Oxford. He was an accomplished musician, a learned student of architecture, and in his day a most successful lecturer on ancient history. Philosophy was with him only one among many interests which claimed his attention almost equally. In philosophy he was as one born out of due time. A man of singularly individual mind and temperament, he took his own line in philosophy, and vigorously resisted the semi-Kantian, semi-Hegelian idealism which in his earlier days became the prevailing philosophy at Oxford. But though he resisted it, the influence of Green and Wallace, of Bradley and Bosanquet, was too strong for him, and he remained to a large extent a solitary figure among Oxford philosophers—less fortunate in this respect than Cook Wilson, whose reaction against idealism carried with it the support of many of his younger colleagues. Wilson's realism was, it must be admitted, the better based and the more philosophical of the two.

Case was always somewhat too dogmatic in his mode of thinking and of presentment. His own insight was often keen and penetrating, and he was too apt to assume a readier assent to what to himself seemed clear, than he was actually likely to receive from the average reader. It must be confessed, also, that he was capable of strange blunders. In his first

book, "Physical Realism" (1888), while he says much that is acute and well worth reading, he puts forward a theory of the object of perception which is one of the least plausible of all theories on the subject—that what we see or hear is our optic or auditory nerves coloured or resonant.

Apart from this book, Case's chief philosophical writings are the articles on logic, on metaphysics, and on Aristotle in the 11th edition of the "Encyclopædia Britannica." The article on metaphysics is a learned and able study of the main trends of metaphysical thought in modern times. That on logic, while devoted in part to expounding the views of Case's two heroes in philosophy, Aristotle and Bacon, shows considerable appreciation of the advances made by the subject in the nineteenth century. The article on Aristotle is notable for the attempt, in which Case to a large extent anticipated the brilliant German scholar Werner Jaeger, to trace a development in Aristotle's thought as between different writings and to use this as a reason for the determination of their dates. Two of his main contentions, that the "De Interpretatione" and the "Eudemian Ethics" stand on the direct line of development from Plato's thought to that most typical of Aristotle, and are therefore genuine and early works, are likely to stand the test of time.

To the younger generation at Oxford, Case's attitude on political and academic questions seemed to be that of extreme Toryism. But he himself insisted that he was not a Tory but a Palmerstonian Liberal. He was, first and last, above everything else an individualist. What could not be doubted by any one was that he was an able, public-spirited, and extremely formidable fighter in whatever cause he espoused. Oxford had no more genial, clever, and amusing resident than "Tommy Case," as he was universally called, *amoris causa*.

SIR JOHN MACALISTER.

SIR JOHN YOUNG WALKER MACALISTER, who died in his seventieth year on December 1, had been for many years secretary and consulting librarian to the Royal Society of Medicine, a post in which his imagination, energy, and personal charm enabled him to do great things. The second son of Donald MacAlister of Tarbert, Cantyre, he was educated at Liverpool High School, studied medicine for three years at Edinburgh, and was then driven by ill-health into the quiet waters of librarianship, only to spend the rest of his life in overflowing his banks, much to the benefit of the surrounding country. He passed rapidly from a sub-librarianship at Liverpool to librarianships at Leeds, at the National Liberal Club, and finally, in 1887, at the Medical and Chirurgical Society, then uncomfortably housed in Berners Street. Under its new librarian's inspiration, the Society soon moved to a fine house at 20 Hanover Square, where it became the benevolent landlord of many other associations.

While the Medical and Chirurgical Society was developing in its new quarters, MacAlister put in eleven years of fine work as the honorary secretary of the Library Association, which he piloted until it obtained a royal charter in 1898. He also founded *The Library*, which for ten years was the organ of the Association, for twenty more an independent quarterly,

and six years ago was handed over by him to the Bibliographical Society, which itself had been founded, in 1892, at a meeting at 20 Hanover Square, brought together by MacAlister. By 1905 his ideals for the Medical and Chirurgical Society had taken definite shape, which led to the building of its present fine quarters at the corner of Wimpole Street, where it now thrives as the Royal Society of Medicine, with some four-and-twenty associated societies under the same roof. At the dinner which was given to MacAlister in 1920, after he had been knighted, Sir William Osler, who was in the chair, hailed him as the layman who had done more for the profession of medicine than any doctor, a fine achievement for a man who had been prevented himself by ill-health from adopting it as a career.

Current Topics and Events.

OUR readers will accord hearty congratulations to Prof. W. C. Unwin, F.R.S., a veteran of the engineering world, who celebrates his eighty-seventh birthday this week, namely, on December 12. An Essex man, he was educated at the City of London School, and afterwards became a pupil in the firm of William Fairbairn, Manchester. Following the managership of engineering works, he was engaged as instructor at the Royal School of Naval Architecture and Marine Engineering, South Kensington, 1868-72; afterwards as professor of hydraulic engineering at the Royal Indian Engineering College, Coopers Hill, 1872-85. Prof. Unwin then took up a professorial post at the Central Technical College of the City and Guilds of London, occupying this for twenty years. One might have thought that this long period of strenuous work would have dulled endeavour, but it was otherwise. In 1911 he was president of the Institution of Civil Engineers. At a conference there in that year on the training and education of engineers, Prof. Unwin said: "I believe the idea that a college course unfits a man for practical work is a wholly mistaken one . . . the view of the employer who looks only to the immediate usefulness of the student is a short-sighted one." On retirement from office the late Sir William White emphasised that "Unwin was looked upon as a master and teacher of the science of engineering." In 1915 the professor was elected president of the Institution of Mechanical Engineers. His portrait, painted by Harold Speed, may be seen there—testimony to service. Prof. Unwin's views on the organisation of research work on British timber may be quoted as of current interest. Speaking at the Royal Society of Arts, in 1913, he remarked that if a forest laboratory were established on any considerable scale in Great Britain, the discovery of information about our colonial timbers would be of even greater importance than that dealing with home forest products. So recently as April last, Prof. Unwin took part in the discussion of a paper by Mr. G. A. Hankins on "Hardness Research Tests," at the Institution of Mechanical Engineers.

PROF. JOHN T. CASH, F.R.S., formerly Dean of the Faculty of Medicine in the University of Aberdeen, will be eighty-one years of age on December 16,

WE regret to announce the following deaths:

Mr. R. G. Backall, a pioneer in X-ray work at the London Hospital and the recipient in 1923 of the honorary certificate of the Carnegie Hero Fund, on November 29, aged forty-four years.

Prof. E. D. Campbell, chief of the chemical and metallurgical laboratory in the University of Michigan, member of the Iron and Steel Institute, known for his work on the constitution and magnetism of iron-carbon alloys, who was blind for the past thirty-three years, on September 18, aged sixty-two years.

Dr. W. R. Dykes, secretary of the Royal Horticultural Society and an authority on the genus *Iris*, on December 1, aged forty-eight years.

Mr. W. P. Hiern, F.R.S., author of "*Dicotyledons*" (1896-1900) and of a monograph on the *Ebenaceæ* (1873), aged eighty-five years.

and to him also our cordial congratulations are extended. After graduating at the University of Edinburgh, he engaged in scientific research at Berlin, Leipzig, and in London. He collaborated with the late Sir Lauder Brunton, F.R.S., in a series of medico-chemical studies, detailed in papers, notably "Contributions to our knowledge of the connexion between chemical constitution and physiological action"; "On the effect of electrical stimulation of the frog's heart and its modifications by heat, cold, and the action of drugs"; "Action of caffeine and theine upon voluntary muscle."

IMMEDIATELY after the tragic death of Prof. Maxwell Lefroy on October 14, an appeal was made to the public to subscribe twenty thousand pounds to establish a memorial to him. The institution which made this appeal is called the College of Pestology (Incorporated), with a registered office in Bedford Square, London. The "College" is not included, however, in any standard book of reference of educational institutions, and apparently it exists as such an institution only in name, for there seem to be no laboratories or staff, except the honorary director, Mr. A. Moore Hogarth. It formerly existed as the Incorporated Vermin Repression Society, and the present name was assumed only two or three years ago. The "College" has, of course, no connexion with the University of London, and its title is therefore a little misleading to those who do not know the difference between a propagandist body and an educational institution. We have complete sympathy with what the organisation has done in directing attention to the danger and destruction due to rats, mosquitoes, and other pests, but it is another matter to ask the public to subscribe twenty thousand pounds for "a chair and centre of applied biology at the College of Pestology, Bedford Square." If a memorial is contemplated, surely the right place for it would be the Imperial College of Science, South Kensington, where Prof. Lefroy had his laboratory, and where he met with the accident which led to his death. In any event, a matter of this kind ought not to be in the hands of a small committee connected with such an unofficial organisation as the College of Pestology, but of a representative group

which would include Prof. Lefroy's scientific colleagues. We hope, therefore, that further consideration will be given to the proposal and the constitution of the appeal committee before subscriptions are sent in response to the circular letter recently distributed.

THE Streatfeild Memorial Lecture was delivered on December 3 at the Finsbury Technical College, London, by Mr. F. H. Carr, who spoke on "The Scientific Basis of Industry," and dealt chiefly with the training of chemical engineers, and with the possibility of prolonging the existence of the College in a new form. Like many others, Mr. Carr regrets the impending dissolution of "Finsbury," which was a pioneer in teaching the elements of engineering to chemical students, and in educating them for industrial careers. The view is often expressed, and Mr. Carr seems to share it, that the successful application of science to industry is the main pivot upon which civilisation hangs, and that the future belongs to those nations which can attain a higher standard of living and shorter hours of work by substituting machines for human labour. This material view of progress may be sound economically, and we know that there is a constant interaction between the material and the non-material, but surely such factors as character, courage, adaptability, and eugenics are at least of equal importance. Herein, we believe, lay the weakness of those who favoured specialised training for the immature in the isolated technical college, as against training in the much wider culture offered by the university proper. Man cannot live by bread alone, and even the highest technical efficiency cannot save a nation if it is wanting in the more spiritual virtues. It is therefore with interest that we note Mr. Carr's suggestion that the future of "Finsbury" should be in a close association with the University of London. In the past, he says, chemists have been trained on lines that were too stereotyped; the student with little aptitude for abstract studies, but with great potential capacity for technology, has failed to profit from the ordinary degree-course in science; and the fault lies with the course of study, not with the student.

IN 1914, Great Britain was crying out for men who could apply science to industry, and particularly for chemical engineers. The need is still urgent. The Ramsay Memorial Laboratory of Chemical Engineering at University College, London, lacks endowment and the necessary means to develop. The Finsbury Technical College is about to be closed down. Why not, says Mr. Carr in effect, solve the three problems simultaneously by accommodating the Ramsay Laboratory in the Finsbury buildings, and asking the City and Guilds of London—or a private benefactor—for a generous endowment? The idea is ingenious and well worth examination; but whether it be accepted or not, there is no doubt of the need in Great Britain of a great school of chemical engineering comparable in magnitude and efficiency with those possessed by Germany, Switzerland, and the United States, which, as the lecturer pointed out, have been

responsible for some of the greatest recent advances in applied chemistry. Such a school would require not only a different equipment, but also a different curriculum from those now in use in our universities. To obtain admittance, the student should have reached the standard of the London Intermediate Science Examination; training in engineering should not wait upon an advanced knowledge of organic and physical chemistry, but should precede or accompany it. Adequate provision should be made for research in applied chemistry, which demands a more mechanical type of technique than that upon which chemical technologists have been reared in the past; and special attention should be given to bridging the gap between laboratory and works. It is a fallacy to think that any one type of chemical education is suitable for all. The student who is to control plant or manage a works requires more than a good foundation of general science; he needs an insight into works' problems, and special knowledge that will help him to solve them.

At the opening of the National Radio Conference, held at Washington in November, Secretary Hoover said that the interests of the listening public must come before all other interests. He first pointed out that the leading position in the international field is taken by American radio-telegraphic companies. Direct service with Sweden has been commenced, and in another year telegraphic communication will be established with practically every country in the world. During last year there was a great increase in the number and the power of the broadcasting stations in the States. Last year there were 115 stations using 500 watts or more and generating a total power of 67,500 watts. There are now 197 stations and the total power has increased to 236,500 watts. The desire for publicity is the basic motive, and furnishes the financial support for almost all the broadcasting that is taking place. Listeners may well object to their sets being monopolised at stated times by advertising matter. In the future it will be necessary to distinguish between unobtrusive publicity accompanied by an engaging entertainment and unobtrusive advertising. The problem of interference has become a serious one. In the States there is a total of 578 stations, no more than four of them being under the same management, and there are now pending 175 applications for new broadcasting stations. Something therefore has to be done. A few high power stations operating full time give a far better service than many smaller stations operating for part time only. Mr. Hoover considers that the allotment of wave-lengths, the control of power, and the policing of interference should be in the hands of the Federal Government. Although radio is not circumscribed by State lines and still less by city boundaries, it is possible to establish zones which roughly correspond to service areas. Each zone might be entrusted with the settlement of its own local problems.

EVERY year brings forward new evidence that insects are important factors with reference to

public health, and the list of diseases that are partially or entirely spread through the agency of these organisms is steadily increasing. The first human disease to be traced directly to an insect carrier was malaria, and this discovery gave the impetus which has led to the recognition of the extensive rôle played by insects in disease-transmission, either from man to man or from one animal to another. The efforts of the entomologist, coupled with those of sanitarians and doctors, have resulted in truly remarkable progress being made in the reduction and restriction of such diseases as yellow fever, malaria, typhus fever, and plague. The subject of "Insects in Relation to Public Health" was selected by Sir Wilfred Beveridge for a Chadwick Public Lecture delivered by him in the Barnes Hall of the Royal Society of Medicine on November 18. Apart from its value in economics and the prevention of disease, the study of insect life, Sir Wilfred maintained, generates the quality of accurate discrimination and develops the capacity for observation. A knowledge of entomology, he added, is essential to every medical man, but training in that subject is generally restricted to those who embark on public health work or practise medicine in the tropics. A knowledge of entomology likely to be of real value must not be confined merely to the study of insects which are at present known to be injurious, but should be sufficiently comprehensive to enable the student to be prepared for any new problem that may arise. The measures in vogue for combating flies and other insects carrying disease germs were referred to, and Sir Wilfred showed the importance of regulating our sanitary efforts so as to reduce the breeding places of such insects. In dealing with the planning of preventive measures, the importance of studying natural methods of control was pointed out, and how they should be emulated so far as may be possible in the campaign against noxious insects.

PROF. F. G. PARSONS delivered at St. Thomas's Hospital on December 4 an interesting lecture on the early inhabitants of London, illustrated by specimen skulls of the Long Barrow type—surviving among the miners of the Forest of Dean—the Beaker folk and the Celts or prehistoric Nordics. Evidence pointed to Cymbeline as a possible founder of London. His capital was at St. Albans, and the position of London may have been selected for purposes of trade at a point lower down the river than the earliest ford at Westminster. Cymbeline's name is recorded in the name of the Buckingham villages, Great and Little Kimble, in the Chiltern country, which was the limit of his kingdom. That the earliest site of London was in the south of Cornhill is indicated by two lines of evidence: first, the absence of Roman interments in that area, and secondly, the recently discovered relics of Boadicea's burning of London. The converging Roman roads are evidence of the importance of London. Melitus, the first Bishop of London, ruled in the early part of the fourth century. The lecturer also dealt with the second Nordic incursion and the relations of the Saxons, Franks, Angles, Frisians and so-called Jutes to London.

SIR RONALD ROSS is leaving for Ceylon on the s.s. *Yorkshire* on Friday, December 11. His journey is being undertaken at the invitation of the Ceylon Association and he will investigate conditions in the island from the point of view of malaria control. Plantations in various areas will be visited, and Sir Ronald hopes to be able to advise as to methods which should be adopted in combating the disease.

THE sixteenth annual exhibition of the Physical Society of London and the Optical Society, which is to be held on Tuesday, Wednesday and Thursday, January 5, 6 and 7, at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, will be open in the afternoon (from 3 to 6 P.M.) and in the evening (from 7 to 10 P.M.). The following lectures have been arranged:—Mr. J. E. Barnard, on "The Search for Ultra-Microscopic Organisms," at 8 P.M. on January 5; Prof. A. F. C. Pollard, on "The Mechanical Design of Instruments," at 8 P.M. on January 6; and Major W. S. Tucker, on "Electrical Listening," at 8 P.M. on January 7. Some seventy firms are exhibiting scientific apparatus, and in addition there will be a group of non-commercial exhibits by fellows of the Societies and others, including demonstrations of famous historical experiments in physics, recent physical research and effective lecture experiments. The exhibition will be open to the general public without tickets on the third day, January 7. On January 5 and 6 tickets of admission, obtainable from the secretaries of scientific societies or from Prof. A. O. Rankine of the Imperial College of Science and Technology, will be required.

THE scientific society known as the Priestley Club, founded in 1875 for the purpose of promoting the discussion of scientific topics and of facilitating the social intercourse of scientific men in Leeds and the West Riding of Yorkshire, is to celebrate the attainment of its jubilee by a dinner in the University, Leeds, on Tuesday, December 15. The members of the Club include chemists, physicists, biologists, mathematicians, medical men and technologists who, for the most part, are engaged in scientific work at the University of Leeds or other institutions, in the industries of the neighbourhood, or in the practice of the learned professions. The speakers will include Sir J. C. Irvine, Principal of the University of St. Andrews; Dr. J. B. Baillie, Vice-Chancellor of the University of Leeds; and Prof. Arthur Smithells.

THE weather in Canada during October, as shown on the weather map of the Canadian Meteorological Service, was abnormal in several respects. In arctic Canada the weather was warmer than usual in that month, in some places by so much as 6° F., while elsewhere it was a cold October, and in some parts, as Saskatchewan, the coldest October for fifty years. In British Columbia there was a remarkable deficiency of rainfall; in Saskatchewan the deficiency was less marked, and in Alberta all districts except the extreme south-east had an excess. In eastern Canada there was much more snow than is usual in October and precipitation generally was in excess of the normal. Threshing and ploughing in the prairies were carried

on with great difficulty, and in some districts considerable work was unfinished at the end of the month. Nowhere, in fact, was October a favourable month for agricultural work.

THE majority of modern scientific appliances are the results of team work, and the cinematograph is no exception to this. So long ago as 1870, Henry Heyl exhibited on a screen in Philadelphia a series of posed pictures showing the movements of a couple dancing, but it was C. F. Jenkins, of Washington, who invented the first practical projector for throwing on the screen life-sized pictures from films taken of living moving objects. His first public exhibition took place in 1894 in Richmond, Indiana. The following year the brothers Lumière gave a public exhibition of cinematograph pictures in a café in Paris. The site of this, the first cinema hall in the world, is No. 14 Boulevard des Capucines, and we note with interest that the municipality of Paris is to commemorate the event by placing a tablet on the building which now stands on the site.

THE lecture arrangements at the Royal Institution before Easter next year have recently been announced. The Juvenile Lectures will be delivered by Sir William Bragg on "Old Trades and New Knowledge," commencing on December 29 at 3 o'clock. On Tuesdays, at 5.15 P.M., beginning on January 19, there will be two lectures by Dr. J. A. Crowther on "X-rays and Living Matter"; two by Dr. E. K. Rideal on "Surface Action"; four by Prof. J. Barcroft on "The Egg"; and two by Dr. C. H. Desch on "The Growth of Crystals." On Thursday, January 21, at the same hour, Dr. C. J. Patten will give the first of two lectures on (1) "The Language of Birds," (2) "The Breeding Factor in Birds." These will be followed by three lectures by Dr. J. L. Myres on "Who were the Greeks?"; three by Dr. C. D. Ellis on "The Atom of Light and the Atom of Electricity"; two by Dr. J. Holland Rose on "The Indecisiveness of Modern Warfare." On Saturday afternoons at 3 P.M. Mr. Henry Balfour will give two lectures, commencing on January 23, on (1) "The Evolution of Currency and Coinage," (2) "The British Coracle, or the Skin-covered Boat and its Affinities." On succeeding Saturday afternoons there will be two lectures on "The Nature and History of the Triad and the Perfect Fourth," by Sir Walford Davies, with musical illustration; two by Dr. George Macdonald on "Roman Britain"; and four by Sir Ernest Rutherford on "The Rare Gases of the Atmosphere and their Importance in Atomic Theory." The Friday evening meetings will begin on January 22, when Sir William Bragg will deliver a discourse on the work of the Davy Faraday Research Laboratory. Succeeding discourses will probably be given by Sir William Hardy, Prof. George Gordon, Prof. Robert Robinson, the Hon. J. W. Fortescue, Dr. C. Hagberg Wright, Sir J. J. Thomson, Mr. John Tweed, Sir Ernest Rutherford, and others.

THE Pathological and Bacteriological Laboratory Assistants' Association continues its successful career under the presidency of Prof. H. R. Dean, of Cam-

bridge. There are now 102 registered members who have obtained certificates of proficiency in various branches of pathological laboratory work, 158 ordinary members and 97 junior members. Regular courses of lectures and practical instruction are organised by the branches, of which the one in London is the largest and most active, and the educational policy which has throughout been pursued is proving very satisfactory. The founders of the Association from the first had in mind the ultimate inclusion of all laboratory assistants in one federation, and the Association admits as associate members laboratory assistants in any recognised scientific laboratory. It is hoped that from this may spring sections following for other branches of scientific work the lines of the educational programme of the parent Association, which is prepared to offer financial and any other assistance which it can. The secretary is Mr. H. P. Hudson, Panama Villa, Trumpington, Cambridge.

THE opening meeting of the Illuminating Engineering Society on November 26 was, as usual, devoted to reports of progress and exhibits of novelties. The customary report of progress, presented by Mr. L. Gaster, referred to the course in illuminating engineering recently established at the Polytechnic, Regent Street, and to the varied work now being done by the committee working under the Department of Scientific and Industrial Research. The latter is dealing, amongst other matters, with methods of lighting necessary for difficult factory processes, and for authority and impartiality it cannot be readily paralleled elsewhere. Equally important is the work of the various British Engineering Standards Association committees concerned with standardisation. It is hoped that these activities will be described more fully at a forthcoming meeting. Another outstanding feature is the development of interest in illumination abroad. There have been frequent references made to this subject at international congresses, and the necessity for Great Britain to be strongly represented at such gatherings was urged. The exhibits included a new form of long-burning enclosed flame arc, from which much is expected; the mutochrome projector, by the aid of which any desired coloured pattern can be built up and projected on the screen; and a new form of integrating photometer exhibited by Col. Kenelm Edgcumbe. Another item was the demonstration of the use of partially colour-sprayed lamps with motor-car headlights; by this means, it is claimed, the greater part of the beam can be limited below a given horizontal plane, with the advantage that the "cut-off" is gradual, a mild diffused light being emitted above this level.

THE Department of Scientific and Industrial Research has published a *Bulletin* (No. 1) of *Building Research*, describing the preparation and use of magnesium oxychloride in flooring compositions. Details are given of the constituent materials, method of mixing and laying, surface treated, the advantages and disadvantages of the material, together with tables of analyses showing the effect of varying the composition on the tensile strength.

AN address delivered in the United States by Prof. Alex. Findlay, of the University of Aberdeen, entitled "The Appeal of Science to the Community," appears in *Science* of October 23. In spite of its immense utilitarian value to mankind, Prof. Findlay considers that the real claim of science to a fuller appreciation is for its idealistic aim, the seeking out of the truth. Prof. Findlay expresses disagreement with those who claim that, on account of the great benefits to be derived from the diffusion of scientific knowledge, men of science should have special power in the general government of the country.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Works chemist and organic chemist—Research Department, The Walpamur Co., Ltd., Darwen, Lancs. (December 15). Assistant at the Commonwealth of Australia Solar Observatory at Mount Stromlo—High Commissioner for Australia, Australia House, Strand, W.C.2 (December 18). Assistant engineer for the Timber Mechanics Section of the Forest Products

Research Laboratory, South Farnborough—Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (January 1). Senior agricultural officer for the Department of Agriculture, Nairobi—Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (January 31). Several men with training in experimental psychology—Secretary, National Institute of Industrial Psychology, 329 High Holborn, W.C.1.

ERRATA.—The writer of the article "Does the Solar Heat Stream Vary?" (*NATURE*, November 21) directs attention to two corrigenda. The quotation from Mr. Clayton on p. 755, col. 2, should read "These were supplemented by telegrams of the maximum temperature observed at Seattle, Williston, and Chicago, in order to ascertain to what extent the temperatures at those stations were responding to solar changes." It should have been stated at the top of col. 1, p. 756, that, with uncorrelated variables, the standard value of a correlation coefficient, computed from 84 samples, was about 0.11.

Our Astronomical Column.

COMETS.—Further observations of Van Biesbroeck's Comet on November 27 indicated that the R.A. of the Möller-Stromgren ephemeris was too small by 1 sec., and its declination too large by 0.7'; these discordances are small, and are in the direction of making the perihelion passage a day or two earlier than September 29, and the perihelion distance slightly greater than 1.447 units. The proximity of the moon has probably prevented later observations.

Comet Wilk-Peltier was observed at Greenwich on December 5 and 6; the approximate position on December 5^d 17^h 16^m U.T. was R.A. (1925.0) 19^h 29^m 59.78, N. Decl. 1° 21' 27". The comet was bright with decided central condensation, and was visible before twilight ended.

The following elements and ephemeris for 0^h are by Dr. A. C. D. Crommelin from observations extending to November 24:

T 1925 Dec 7.2828 U.T.
 ω 126° 22' 35"
 Ω 141 0.16
 i 144 34.17
 $\log q$ 9.88281.

	R.A.	S Decl.	log A.
Dec. 10.	19 ^h 43 ^m 38 ^s	3° 26'	0.0373
14.	19 52 58	7 0	0.0851
18.	20 0 11	9 58	0.1271
22.	20 5 55	12 29	0.1640
26.	20 10 38	14 39	0.1961

The comet will be lost in the sun's rays after January 10 (about), but may still be within reach when it emerges.

TOTAL SOLAR ECLIPSE OF JANUARY 14, 1926.—The Einstein problem has practically monopolised the attention of British eclipse expeditions since the War. It is now considered that sufficient evidence has been obtained to verify the prediction of light-bending, and the observers are free to resume the spectroscopic study of the corona. An article in the *Observer* of December 6 refers to Prof. E. A. Milne's predictions as to the relative intensities of the lines in the coronal spectrum, made on the basis of Bohr's theory. Special endeavour will be made in Sumatra

to test these predictions. In addition to Mr. F. J. M. Stratton and Mr. C. R. Davidson, the party there will include Dr. F. W. Aston.

An article in *Science* for November 20 describes the programme of one of the American expeditions to Sumatra, consisting of Prof. H. T. Stetson of Harvard, Dr. W. W. Coblentz, Mr. W. Arnold and Mr. W. A. Spurr. They are taking a reflecting telescope of 20-inch aperture with radiometric and photometric accessories, and will make measurements of the coronal radiation by vacuum thermo-couples, and photometric studies of the colour and brightness of the corona by photographic methods; these will be in continuation of those made last January in Connecticut. This expedition, and that from Swarthmore College, will be located at Benkulen.

RECENT LARGE SUNSPOTS.—The last sunspot minimum occurred about the middle of 1923. Since that date, solar activity has been rising consistently, and for some months past the increase has been very marked. More recently, there have been three very large spot disturbances visible to the naked eye. Particulars of these are given briefly as follows:

Date on Disc (1925).	Central Meridian Passage (G.M.T.).	Latitude.	Area.
Oct. 14-26	Oct. 20.4	19° S.	1/900
Nov. 8-20	Nov. 13.6	15° S.	1/800
Nov. 18-30	Nov. 24.5	17° N.	1/650

(Areas are corrected for foreshortening and express the proportion of the sun's hemisphere.)

The first of these groups contained a large principal spot with smaller companions. The second consisted of a pair of large spots of remarkably rapid growth and decay, in the place occupied by a moderate spot disturbance in the previous rotation. The third group was a very large stream, some 17° of longitude in length. It was a conspicuous object through the mist and fog prevailing in London on several days towards the end of November, and it was picked up by several people previously unaware of its existence.

It is remarkable that no magnetic disturbances were recorded at Greenwich associated with the transit of these three large spot groups across the sun's disc.

Research Items.

THE FINNISH HOUSE.—Some interesting details of the plan and methods of construction of the traditional type of habitation in Finland are given by Mr. Donald Smith in Part 4 of *Observation*. These houses were constructed to contain several generations, and the communities were self-contained, the men being hunters, fishers, graziers, farmers, and artificers, lacking only a forge; while the women performed the operations of grinding, baking, brewing, spinning, etc. They grew their own tobacco. The first portion of the house to be erected was always the bathroom of round unshaped logs—of the "steam-bath" type, with a stove of rough blocks of granite. Then followed a vestibule used as a store-room and dairy connecting the bath-house with the living-room or house proper. This was roughly square with a seat fixed to the wall running round two sides, and an oven of clay and granite blocks in the right-hand corner. Smoke was emitted by the door or slits in the wall, but sometimes a hollow tree-trunk served as a chimney, its lower end being closed by a slide which was opened at intervals. A trough was provided to give the horses warm meals in winter, for which purpose they were brought in from the stables. The upper end of the room was divided into the man's corner and woman's corner, each pursuing their occupations on their respective side of the line, the woman alone crossing the line rarely as her duties required.

THE EARLIEST MAYAN DATES.—Among the contributions to the Göteborg session of the twenty-first International Congress of Americanists, of which the proceedings have just been published, is an examination of the earliest evidences for Maya dates and the inferences which can be drawn from them, by Dr. Sylvanus G. Morley. The earliest dates known at present are on the Leyden jadeite plaque and the Tuxtla statuette, which show Baktun 8 dates equated, that on the latter with 97 B.C. and that on the former with A.D. 61. It is probable, though by no means certain, that in both cases the dating is contemporaneous. Dr. Morley gives a table showing 29 early dates, of which 24 are certainly or probably contemporaneous and five non-contemporaneous, ranging from 97 B.C. to A.D. 275. Of the dates covering Baktun 8 and part of Baktun 9, the former come from two sites only, Uaxactun and Uolantun. It is established by Steele at Tikal, the latest of the Old Empire monuments, that the Baktuns—the name given to the Maya cycle of 144,000 days—numbered 8, 9, and 10 fitted into a system which could not complete itself in more than sixty-four millions of years. Taking the evidence bearing upon dating as a whole, it would appear that Uaxactun was the first Maya city at which stone monuments came into use. Before that time, it is generally agreed, the stelæ were carved out of wood; and these have now disappeared. Exhaustive search in the region of the oldest cities has failed to reveal any simpler beginnings of the elaborate time count. Uaxactun is at the heart of the Yucatan peninsula and of the Old Empire. Its geographical and topographical position concur with the archaeological and chronological evidence in pointing to it as the central point of distribution of Mayan culture to other regions.

TRYPARSAMIDE IN SLEEPING SICKNESS.—The efficacy of trypanamide in the treatment of sleeping sickness in the Belgian Congo is the subject of a communication by Dr. Clement C. Chesterman in the *Lancet* for November 7, p. 965. He notes that though spontaneous recovery may sometimes occur without

any treatment, he himself has observed no case in a series of 650 which has remained in good health. On the other hand, there is evidence that after single doses of atoxyl, soamin, arsacetin or tartar emetic, early cases may remain in perfect health, while with repeated dosage the number of cases which appear to be cured is greater. Bayer 205 likewise gives good results in cases in the first stage of the disease, which means that there is no involvement of the central nervous system as evidenced by changes in the albumin and cell content of the cerebro-spinal fluid. In the second stage of the disease, none of these drugs gives satisfactory results. In trypanamide, first used in sleeping sickness by Pearce of the Rockefeller Institute of Medical Research, there is hope of permanent cure even in cases in very advanced stages of the disease. Of the first stage cases originally treated by Pearce in 1920, so many as 100 per cent. are still in good health and may reasonably be regarded as cured. Of cases in the second stage, Van den Branden and Van Hoof have carefully followed 35 which were treated with trypanamide. Of these 45.7 per cent. have remained in good health for an average period of three years. Dr. Chesterman himself has obtained cures in 37.5 per cent. of 40 cases observed for two and a half to three and a half years. A number of cases, however, do not react to the drug, and the reason of this is obscure. The drug *in vitro* is only feebly trypanolytic, so that its curative action appears to depend on some factor in the human body. There is evidence that this may be found in the liver, and that when this organ does not function properly, the drug has less chance of acting favourably in sleeping sickness. Dr. Chesterman concludes that trypanamide should be the mainstay of our attack on sleeping sickness. The principle has been adopted by the Belgian Government, which is responsible for the treatment of 50,000 cases annually.

GOLD COAST SURVEYS.—The report of the Survey Department of the Government of the Gold Coast for the year ending March 1925 shows a record of steady progress not only in the production of topographical and cadastral surveys, but also in the attainment of a high standard in local production of maps. In addition to a great deal of cadastral work including several town plans, the topographical survey is proceeding satisfactorily. Of the total area of the Gold Coast and mandated territories, some 92,000 square miles, 41,000 have been surveyed, including 2500 during the year under review. The scale is 1 to 62,500 from the coast to lat. 7° 30' N., and half that scale to the northward. The reproduction of the smaller scale maps is now undertaken at Accra instead of sending them home. To judge from the sheet attached to the report, there is little scope for improvement. Experiments with the use of wireless in longitude determinations are leading to useful results.

AGRICULTURAL POPULATION IN EUROPE.—At the International Geographical Congress at Cairo last April, Prof. A. Demangeon opened a discussion on agricultural systems and schemes of distribution of population in western Europe. The subject evoked so much interest that an international commission was appointed to investigate the matter and prepare reports for a later Congress. In the autumn issue of the *Geographical Teacher*, Prof. Demangeon's paper is printed in full. His conclusions are as follows: The nature of the rural habitat is closely related to the system of exploitation of the land. The isolated farm and small hamlet, characteristic of western

France, Flanders, the Campine, and many parts of England, is very ancient in regions of predominant stock-raising, in contrast to the compact village which may be held to imply the existence, at least in origin, of some form of communal cultivation. The latter is found chiefly on fertile lands which lent themselves to early settlement by reason of lack of forest. Prof Demangeon does not believe that the origin of the compact village can be ascribed to any one people. In France it appears to be a very ancient feature evolved before the Frankish conquest. The article concludes with some contributions by other geographers to the discussion at Cairo.

MIOCENE MOLLUSCA FROM JAMAICA.—A fine volume on the Miocene Pelecypoda and Scaphopoda from Bowden, Jamaica, by W. P. Woodring, part of a series of reports dealing with the geology and palæontology of the West Indies, has been issued as one of the invaluable Publications (No. 366) of the Carnegie Institution of Washington. The work, save for some brief but adequate introductory remarks, is devoted to a systematic description of the species met with. These are estimated to amount to 185 species and subspecies of bivalves and 20 of scaphopods, of which some 85 are claimed to be new, while new sections and genera have also been founded. The accompanying illustrations are included in 28 plates, and are some of the finest we have had the pleasure to meet with. In the treatment of his subject the author has taken a most important step for a palæontologist, since he acknowledges the importance of following the International Rules of Zoological Nomenclature and points out that the "time-consuming task of attempting to discover what generic names should be used has no direct bearing on the history of the earth and therefore may seem like wasted time for a palæontologist. But if the significance of the genera composing a fauna is considered, and their rise, spread, and restriction are analysed, the uniform use of generic names is essential."

MYCORHIZA OF PINE AND SPRUCE.—The relations of the fungus hyphae of various species of Hymenomycete, including species of *Boletus*, *Cortinarius*, etc., to the roots of these forest trees have been very fully investigated by Elias Melin of Stockholm ("Untersuchung über die Bedeutung der Baummykorrhiza." Jena: Gustav Fischer, 1925, 7.50 marks). The fungi have been grown alone in pure culture, and seedlings of the conifers also raised in sterile culture, and their relation to the nutrient medium studied separately and when growing together. Melin concludes that whilst the trees can manage to assimilate inorganic or diffusible organic nitrogen (e.g. asparagin) readily, when the fungus is present they are able to utilise more freely complex organic nitrogen compounds. In this connexion he examines the fruit bodies of the fungi to obtain some light upon the digestive enzymes present in the fungi which may influence the utilisation of such nitrogen compounds. Melin has an interesting note on the effect of water-soluble "phosphatides," extracted from the conifer seeds by the methods of Hansteen Cranner, upon the growth of these fungi in culture. In quantities too small to permit of the result being due to their nutritive value, they excite a markedly catalytic action upon the rate of growth of fungi, which usually grow very slowly in the absence of the root system of the higher plant. Melin suggests these experiments may throw light on the relations of the fungi to the roots. In no case did he find evidence of fixation of atmospheric nitrogen, either by fungus or by fungus and host together.

ATMOSPHERIC ELECTRICITY.—The search for the cause of the potential gradient in the atmosphere has been stimulated by the theory of von Schweidler and Swann, and the September issue of *Terrestrial Magnetism and Atmospheric Electricity* contains a paper by Mr. C. H. Dwight on a search for rapid variations in the earth's electrostatic field. An insulated plate was suspended 8 metres above the roof of the laboratory and connected to one of the deflecting plates of a cathode ray oscillograph tube, the other plate of which was earthed. The two plates were shunted by a resistance of 12 megohms, which prevented secular accumulation of charge on the upper plate. The cathode rays were deflected by the field between the plates, and the light from the fluorescent spot they produced on the screen at the end of the tube was focussed on a revolving photographic film. The records show that there are no rapid variations of the electric field in the atmosphere except during actual lightning discharges.

THE "HOLWAY" DIATHERMY APPARATUS.—Messrs. Newton and Wright, Ltd., 471/3 Hornsey Road London, N.19, describe in a leaflet just issued the Holway diathermy apparatus, in which special attention has been paid to the spark gap. The spark gap consists of an aluminium chamber extensively ribbed on the outside, so that even with a large current it does not become unduly hot. This chamber is provided with an inlet and an outlet tap for gas dielectric, and can also be arranged for use with ether in cases where no gas supply is available. The actual gap comprises a large copper disc heavily silvered, bridging over the space between a pair of heavy copper electrodes, likewise silvered, so that the gap is in duplicate, an arrangement which conduces to a steady current, while affording means of convenient and delicate adjustment. The electrodes, which are mounted on thick mica diaphragms, are provided with radiation fins for cooling. There is no doubt that the surgical efficiency of some diathermy apparatus leaves much to be desired, and it is to be hoped that the design described will effect an improvement.

HYDROGEN PEROXIDE.—A solid hydrogen peroxide, sold under the registered name of "Hyperol," is described in *Chemistry and Industry* for November 20. Hyperol is a stable white crystalline compound of hydrogen peroxide and urea having the formula $\text{CO}(\text{NH}_2)_2 \cdot \text{H}_2\text{O}_2$, and it contains 35 per cent. of hydrogen peroxide. The only impurity is a trace of citric acid which is not sufficient to affect methyl orange. It dissociates completely when dissolved in water or ether, and 1 gm. of "Hyperol" dissolved in 10 c.c. of water produces a 10-volumes strength solution of hydrogen peroxide.

STRUCTURE OF MALEIC AND FUMARIC ACIDS.—A description of an X-ray examination of maleic and fumaric acids carried out by K. Yardley appears in the September issue of the *Journal of the Chemical Society*. Preliminary investigation indicated that maleic acid has four molecules per unit cell, and from this it is shown that the planosymmetry given to the acid from chemical evidence does not exist in the crystalline state. A structure is suggested, and several projections of this on the planes of symmetry are given. On account of the poor nature of the crystals, the measurements with fumaric acid were more difficult; the minimum cell contains six molecules of fumaric acid. Further evidence shows that neither maleic nor fumaric acid has symmetry in the crystalline state.

The International Council for the Exploration of the Sea.

THE report of the British delegates just received shows that the last meeting of the International Council for the Exploration of the Sea, held in Copenhagen on September 1-4, was, though short, an important one in the Council's history, for at this meeting the machinery of the Council, which had grown rather cumbrous, was thoroughly overhauled and in a considerable measure replaced and renewed, in accordance with a plan prepared by the president, Mr. H. G. Maurice, with the help of Prof. Johan Hjort. To take the less important changes first: the main Committees of the Council are now formed on a regional basis, instead of being based partly upon geographical areas and partly upon the species of fish studied. The regional committees which came into being after the War proved to be a very convenient and practical means of getting co-ordinated researches carried out, and the logical step has now been taken of arranging all the main researches of the Council on this regional basis. The "Area Committees" now formed are seven in number—for the North-Eastern Area (the Norwegian Sea east of the 1000-metre line), the North-Western (Rockall, Faeroe and Iceland), the Atlantic Slope (Rockall to Morocco), the Northern North Sea, the Southern North Sea, and two committees for the Skagerrak, Cattegat and Baltic area. In addition, the Statistical, Hydrographical, Plankton and Limnological Committees remain in being.

For each of the area committees there has been appointed a chairman with very definite duties and responsibilities, who will see that the work done in his area is properly co-ordinated in accordance with the programmes agreed upon, and will report on the progress made. Now comes the most important point in the new organisation. The chairmen of these committees, together with the chairman of the Hydrographical Committee, will form a Consultative Committee which will advise the executive of the Council, the "Bureau," on the proper conduct of the scientific work, and must be consulted by the Bureau. (The two Baltic committees will be represented by one of their chairmen only.)

The criticism has sometimes been made of the International Council that its affairs are too much in the hands of administrative delegates, while too little power is allowed to the scientific experts. What truth there may be in this opinion it is difficult to say, but the voting power is limited to the official delegates, who are usually, but by no means always, scientifically qualified, and conditions are conceivable in which the opinion of the experts might not carry its due weight. The new arrangement gives the scientific members of the Council a more definite status and responsibility, for the members of the Consultative Committee are men of scientific standing and voice the opinions of the experts composing the area committees. We regard this new move on the part of the Council as a healthy and fruitful one.

Another new departure resolved upon at the last meeting is the founding of a scientific journal, which will deal with the many aspects of the Council's work, taking cognisance also of similar work done in other parts of the world. The useful short papers hitherto issued by the Council in the series of *Publications de Circonstance* will in future be published in the journal. We understand that the journal will contain also general articles of a comprehensive nature, reviews, and a bibliography, and will be published quarterly, commencing early in 1926. The new journal should serve a very useful purpose in knitting the work of the Council together, and disseminating its results. The editor will be *ex officio* a member of the Consultative and the Editorial Committees. The publication of short reports of a popular nature is also contemplated by the Council.

Apart from these matters of organisation, the delegates' report gives much interesting information regarding the Council's work. Since the War the number of participating countries has increased, particularly among the southern nations, and the area covered by the Council's organisation now extends over the whole seaboard and adjacent waters from the Barentz Sea right down to the coast of Morocco. Only one important country still stands out—Germany, which has not yet resumed membership. It is understood that Germany will shortly rejoin the Council.

Great Britain continues to do the lion's share of the work, particularly at sea, and we are glad to note that she is well represented in the new organisation, Dr. Alex. Bowman being chairman of the Northern North Sea Committee, Mr. J. O. Borley chairman of the Southern, while Dr. E. S. Russell is editor of the journal. Mr. Maurice continues his energetic work as president, and the other British delegate, Mr. David T. Jones (who has succeeded Prof. D'Arcy W. Thompson in this office), presides over the two North Sea Committees when they meet in consultation over problems common to both. Prof. Thompson remains chairman of the Statistical Committee and editor of the *Bulletin statistique*.

Other points of interest in the British delegates' report we can touch upon only briefly. At their request a special committee was appointed to study the very vexed question of the closure of the Moray Firth to trawling, consisting of Norwegian, Danish, Dutch, Belgian and British experts. Reference is also made in the report to investigations commenced by the English Department during the present year on the effect of the size of trawl mesh on the size of fish caught, which are yielding promising results. Finally, we are glad to learn from the report that His Majesty's Government has agreed to support the Council's work for a further period of five years. Results in fishery and oceanographical research cannot be obtained quickly, and the long view will prove in this case to be the wise view.

Relation between Physical and Mental Defects.

A PAPER on the testing of physically defective and of mentally defective children, by Dr. C. R. McRae, who was obliged to return to Australia some days before the recent meeting of the British Association at Southampton, was read before the Section of Psychology. The paper was divided into two parts.

(1) THE BINET-SIMON TESTS AND SPEARMAN'S PRINCIPLES OF COGNITION.—These principles, as enunciated in Prof. Spearman's book, "The Nature of

'Intelligence' and the Principles of Cognition," offer an explanation of the remarkable success of the Binet-Simon tests of intelligence. Of particular importance are the noegenetic principles concerning the eduction of relations and the eduction of correlates. On the basis of these principles an *a priori* analysis and criticism of each component test of the Binet scale was made. To test the validity of this analysis in practice, both physically defective and mentally

defective children were tested. The most satisfactory tests of innate ability should be those in which superior natural endowment enabled the physically defective children furthest to outstrip the mentally defective despite inferior educational opportunity, while the least satisfactory tests would be those in which superior educational opportunity enabled the mentally defective to approach nearest to the physically defective.

A close agreement between the theoretical judgment made on the basis of the noegenetic principles and the practical decision obtained by testing these children was found to exist. Thus it seems likely that Ebbinghaus's completion test is a satisfactory mental test, not because "intelligence" consists in "combination activity," but because the performance of the test is mainly a matter of educing novel correlates, or that the "opposites" test succeeds, not because "intelligence" consists in seeing differences, but because the performance of the test is essentially a matter of educing relations.

(2) PHYSICAL DEFECT AND MENTAL EFFICIENCY.—Children in metropolitan schools for the physically defective, and patients in the Lord Mayor Treloar Hospital at Alton, were tested. The London children show a retardation of 1.95 years, the Alton children of 1.14 years. This difference of almost a year in favour of the Alton children was found on analysis to be inexplicable in terms of social environment and heredity, of the nature of the physical defect or of educational opportunities. One explanation alone

seemed feasible, that the alleviation brought to the physical defect by the medicinal measures and environmental conditions of the Hospital stimulates the mind as well as the body.

	Metropolitan Schools.	Alton Hospital
No. of cases . . .	117	62
Average age . . .	11.13 years	11.85 years
Average mental age .	9.18 years	10.71 years
Average mental ratio	82.5	99.4

Sir Henry Gauvain, Medical Superintendent at the Hospital, is inclined to invoke as explanation of the mental superiority of the Alton children the setting free from the skin by ultra-violet rays of certain organic compounds which are essential brain foods. Whatever the true explanation may be, it would appear tolerably certain that physical defect, if widespread and of long duration, simulates the symptoms of some degree of amentia, and that these symptoms may be removed by such treatment as is afforded at the Treloar Hospital. In the ensuing discussion, Dr. Shrubsall questioned the validity of pooling the London children together, as they represented several specified categories of diseases. It was stated, however, on behalf of Dr. McRae, that this point had been considered in his full report, of which the present paper was a partial summary.

New Laboratories at St. Andrews.

NEW chemical and physical laboratories were opened by Sir William Bragg at the United College of St. Salvator and St. Leonard, University of St. Andrews, on the afternoon of Friday, December 4. Before proceeding to the new building, Sir William Bragg, who received a cordial welcome in the city of the scarlet gown, was promoted to the honorary degree of LL.D. at the hands of Sir James Irvine, Vice-Chancellor. Mr. William Whitelaw, chairman of the London and North-Eastern Railway Company, was the recipient of the same honour. In a memorable address, Sir William Bragg described the modern developments of atomic and molecular theory, pointing out the extreme delicacy of the method of X-ray analysis, not only in determining the structure of crystals, but also in measuring the length of one of the curious chain-like molecules which are based on carbon links. He emphasised the importance of inquiry into details in pure and also in applied science. It is that intimate examination of details which results in the advance of knowledge, and affords so fascinating a prospect to the inquirer.

The new building opened by Sir William adjoins the Chemistry Research Laboratory and runs southwards with a frontage of 170 feet. It is in the Renaissance style, two stories high, and faced with local sandstone from Nydie. Above the entrance doors are mullioned windows and a moulded gable, in keeping with the seventeenth-century type of work of the old quadrangle. The architect was Mr. J. Donald Mills, and the internal benches and fittings were designed in collaboration with Prof. J. Read, of the Chemistry Department, and Prof. H. S. Allen, of the Department of Natural Philosophy.

The chemistry accommodation, which is located in the northern part of the block, forms an extension of the institute for chemistry research, which was presented to the University and endowed by the late Prof. Furdie. This institute, which has been re-

organised during the alterations, contains accommodation for twenty research workers, in addition to rooms for special purposes. For the past twenty years the research institute has been widely known as a centre of research work on sugars and carbohydrates, problems of optical activity, and general synthetic organic chemistry; during the War much important work was carried out within its walls under the supervision of the present Principal and Vice-Chancellor, Sir James Irvine.

The new accommodation for chemistry tuition comprises on the ground floor an elementary laboratory, containing bench space for forty students at once, together with a balance room and other service rooms. A fully equipped laboratory for advanced students occupies a position on the first floor; this has accommodation of the most modern type for eighteen students, and is provided with fume-chambers, apparatus for organic combustion work, steam-ovens, and other necessary accessories. Adjoining it are a small balance room and two physical chemistry rooms, to which low voltage current is supplied from an accumulator room. The addition also includes private rooms for members of the staff, a chemistry museum, a lecture room for advanced classes, and store accommodation. A telephonette system has been installed throughout the building.

The Physical Laboratories are contained in the southern block, and have been fitted up to provide for advanced teaching and research, as well as for the usual elementary courses. On the ground floor is a large laboratory for elementary students, together with dark rooms for photographic and optical work, and two rooms which are available for research work. On the same floor is a mechanic's shop provided with machine tools, each driven by its own electric motor. Above is a long room which is arranged as a photometer room. On the first floor is the advanced laboratory, which adjoins the reading room and reference library, so that students can write

a record of their experimental work and immediately refer to the standard authorities on the subject of their experiment. On the same floor are the professor's room, three research rooms, and an optical room. The laboratories are well equipped with gas, water, and electric light and power, provision being made for an electric supply from accumulators in a separate building. At the top of the main staircase is a large room which is being arranged as a laboratory for experimental mechanics. Research work is already in progress, and is at present directed to the study of band spectra, for which purpose two large spectrographs have been installed.

University and Educational Intelligence.

BIRMINGHAM.—The University has received a magnificent gift from Sir Charles Hyde, Bart, who writes to the vice-chancellor: "It will give me the very greatest pleasure to put at your disposal the sum of 100,000*l.* unconditionally for the immediate needs of the University." The donor mentions in his letter some of the more pressing needs of the University which are known to him, namely, a Union building for the students; an extension of Chancellor's Hall (the hall of residence for men); the extension of the Harding Library; the purchase of certain land (if it can be bought at a reasonable price); and "the endowment fund of the research committee, which I consider of the most supreme importance." The vice-chancellor (Sir Gilbert Barling, Bart.) states that the gift will be applied to all these objects. Sir Charles Hyde has long been a generous benefactor to the University, and during his tenure of the office of warden of the Guild of Undergraduates, he showed himself particularly interested in the welfare of the students and keenly alive to the advantage of providing residential facilities. Sir Charles Hyde's wisdom in making the gift "unconditionally" is much appreciated and indeed greatly enhances its value. It is understood that no part of the money will be used for the building of the new biology block which is in course of erection.

In addition to the generous gift of Sir Charles Hyde, referred to above, a donation of 2400*l.* from the Miner's Welfare Committee has been given towards the further equipment of the coal-mining department.

Dr. Ratcliffe has presented to the anatomical department casts of fossil remains of Rhodesian man. The Council has decided to establish an honours school in geography.

CAMBRIDGE.—The University Commissioners have issued regulations for initial appointments to lectureships and demonstratorships under the new statutes. Roughly these regulations provide that, within certain age limits, all persons who have held college lectureships for three years or were University lecturers or demonstrators on October 1, 1924, are to be offered lectureships or demonstratorships under the new regime. An appointments committee is to be nominated by the Council of the Senate to fix the financial terms of each offer. It will be a matter of interest to note whether this committee merely contents itself with making such offers that each person concerned receives the same salary as heretofore, or if it makes a definite effort to interpret the spirit as well as the letter of the Statutory Commissioners' recommendations by regulating salaries according to services performed.

SIR THOMAS KIRKE ROSE, past-president of the Institution of Mining and Metallurgy, will deliver an address on "Metallurgy and Minting" at the Sir John Cass Technical Institute, Jewry Street,

Aldgate, London, E.C.3, on December 15, on the occasion of the annual distribution of prizes and certificates.

From the Battersea Polytechnic we have received a copy of the Principal's report on the work of the session 1924-25. A summary of student hours per week shows that the decrease which has been going on since 1921 continued last year. The evening class work, however, showed an increase, and the number of students taking courses in preparation for university degrees increased from 190 to 210. Technological courses for flour millers and lectures on hygiene and sanitary science were attended by twice as many students as in the previous year. Forty-two students obtained degrees of the University of London, including 19 B.Sc. honours degrees in chemistry. The Polytechnic was attended by 68 university graduates for advanced technological instruction.

THE fourteenth annual Conference of Educational Associations will be held at University College, Gower Street, London, W.C.1, on December 31-January 8, under the presidency of Prof. A. C. Seward, vice-chancellor of the University of Cambridge. Prof. Seward will deliver his presidential address, entitled "The Relation of a University to Secondary Education," on the first day of the Conference. Other noteworthy features of the provisional programme are: a joint discussion on the relation of technical education to other forms of education and to industry (Dr. Schofield, Miss Fox, and others); a lecture by Dr. Harold Wager to the School Nature Study Union on "Some Aspects of Nature Study"; and a lecture by Sir Robert Blair to the London Head Teachers' Association on "Education and Industry." Exhibitions are being arranged of books and school apparatus.

THE annual report of the Royal Technical College, Glasgow, for the session 1924-25 records a decrease in the number of day students from 1006 to 936, and an increase in evening students from 3810 to 3817. Considering the depression in the Clyde industries, the decrease is surprisingly small. The Clyde engineering apprentices form the principal reservoir from which the College students are drawn, and the report points, with justifiable pride, to the fact that although only half as many apprentices have been engaged in the local shipbuilding and engineering works as before the War, the number of College engineering students taking a degree or diploma course is almost double the corresponding pre-War figure. There is evidence of revival in the demand for trained chemists and metallurgists. the College has not been able to respond to all the requests for qualified metallurgists and the list of unemployed chemists is small. Some indication of the range and standard of the evening classes is given by the number (148) of graduates of universities (English, Welsh, and Irish, as well as Scottish) enrolled in them and the number (2648) of students more than twenty years of age. Six students received the Ph.D. degree of the University of Glasgow, 95 the B.Sc. of Glasgow, and 4 the B.Sc. of London. The College received during the year substantial recognition of esteem in the form of a gift of 50,000*l.* from an anonymous donor and an undertaking by the Carnegie University Trust to continue for five years an annual grant of 1000*l.* and increase it by 120*l.*, provided that sufficient money from other sources is forthcoming to form, with 5000*l.* of the Trust's grants, an endowment for a chair of metallurgy. The first number of a new official College journal appeared during the winter and contained the results of research work in the departments of chemistry, mechanical engineering, metallurgy and bacteriology.

Early Science at Oxford.

December 14, 1683. The peice of Iron which had been cast into an Ingot, lying North and South, was produced. We did not observe that it did in ye least draw ye needle. A letter from Mr. Aston gave an account that *Gerbertus* brought ye use of numeral figures into these parts of the world; it was ordered that enquiry should be made whence this appears. A letter from Dr. Tyson related to ye observations, lately made by Dr. Bagly on ye *Lumbricus latus*, with an account, and draught, of a little Insect, which he found in ye *Trachæa* of ye *rana Piscatrix*. Dr. Smith was pleased to oblige us, with an account of some observations, made by ye learned Mr. Greaves, in Ægypt, and transcribed from his MS, by ye Doctor, to whom it was communicated by Mr. Stubbs, formerly of Wadham Colledge.

1686. The Minutes of ye Royal Society were read, which gave an account of some cubical *Stones* of a substance resembling a *Marchasite*. Dr. Plot tells us they are ye *Ludus* of Van Helmont, and that he has great variety of them by him, which have been found in Staffordshire, Pembroke-shire, Merionidh-shire, and Carnarvonshire; and that in his History of Staffordshire he has mentioned them.

An account communicated by Mr. Caswell, how and in what proportion the Quicksilver may stand at different heights, reckoned on ye plates of different *Baroscopes*, though filled in ye same place, and with quicksilver equally free from air.

Some Observations of ye *weather* in ye hottest week of ye last summer 1686 made joynly with ye Baroscope and Thermoscope at several hours of the day, in order to find how much heat affects ye Baroscope. By Mr. Caswell.

A peice of *Tin-ore* usually called Shoad, found above-ground, and native copper as found in the West of Cornwall, were communicated by Dr. Plot.

December 15, 1685. A Letter from Mr. Molyneux concerning ye circulation of the blood as seen in the *Lacerta Aquatica* was communicated and read.

A Letter of Mr. Flamsteed's concerning ye eclipses of Jupiter's satellits in ye year 1686 was read.

Mr. LLOYD communicated some stones like ye *Lapides judiaci*, and others like Shell-fish, which were gathered in this County.

A Paper of Mr. Bayly's containing an account of the application of a needle to a piece of iron held perpendicular, made by one in a voyage crossing ye line was read.

December 16, 1684. Our President, and Director, being now returned home, we had a full meeting, in which was read Sir William Petty's Catalogue of Experiments. Dr. Plott was pleased to shew us a piece of cloth, which he brought from London, woven and made with ye flax of ye Amianthus, or Asbestos-stone; which before Mr. Vice-chancellor, and some other Doctors of the University (who were then pleased to honour us with their presence) was heat for some considerable time red-hot, with no other alteration, after it was cold again, save only it appeared somewhat whiter, and cleaner, than before; and was, whilst hot, more brittle; but being cold; of ye same strength, and toughness, as before calcination; which it had now undergone 5 or 6 times; contrary to our Paper made of ye Anglessey-Asbestos, which, being of a shorter thread, was at ye first of a contexture not so tough and strong, as ye cloth, and after ye fire is so friable and brittle, as not to endure any bending, nor ye very handling, if any thing roughly: this paper, it was thought, might be made much finer, and whiter, if it could be made also tough, and tenacious for any use.

Societies and Academies.

LONDON.

Royal Society, December 3.—W. A. Bone and G. W. Andrew: Studies in catalytic combustion. Pt. ii. The union of carbon monoxide and oxygen in contact with nickel, copper, and other oxides. With nickel gauze at 365° C., the formation of a highly reactive Ni-CO (or possibly O-Ni-CO) complex in the surface layer may become a prime factor in the catalytic combustion. The action of the metal may really be of a dual character, involving (a) the "activation" by the metal of the two gases marked by a comparatively low rate of carbon dioxide formation, and (b) the intermediate formation of still more reactive CO-Ni-O complexes. With copper gauze at 135° and 250° C., for the real "catalytic" reaction, no prior formation of either copper oxide or any Cu-CO complex was required, but only the "occlusion" of the respective gases. With granular nickel oxide at 150° C., and granular copper oxide at 165° to 175° C., respectively, the catalytic action depends upon the formation at the surface of an "activated" oxygen film probably of more than monomolecular thickness. The real catalytic combination of carbon monoxide and oxygen over all these surfaces is independent of either the oxidation of a primarily formed "carbonyl" film or the reduction of a metallic oxide.—F. H. Constable: Immobile groups of atoms with strong, specific external fields as the cause of catalytic activity. Copper surfaces made by electrolytic deposition, reduction of alkaline copper solutions, and by hammering and polishing, have an activity probably less than 1/9000th that of the reduced metal. When the surface was produced by sudden cooling of the vapour, or by thermal decomposition of copper salts of organic acids, or by reduction of copper oxides, a markedly active product was obtained. The passage of ammonia gas over the metal at 820° C. produced some activation. The physical appearance of the surfaces varied from a metallic colour, through dull yellow to red-brown. Generally the surface activity and the temperature coefficient of activity were nearly the same. A new method of comparing surface activities of preparations has been devised, depending on the behaviour of copper on alternate oxidation and reduction. The catalytic action is considered to be due to fixing groups of atoms in such a state of strain that strong specific external fields are maintained.—S. C. Roy: On the law and mechanism of monomolecular reaction.—F. A. Williams: The effect of temperature on the viscosity of air. The coefficient of viscosity of dry air free from carbon dioxide has been studied by a comparative transpiration method, with a silica spiral, from 15° C. to 1002° C. The results show that Sutherland's formula for the temperature coefficient of viscosity holds with great accuracy between 250° and 1000°, the value of *C*, the Sutherland constant, in this range being 172.6. Below 250°, Sutherland's law is no longer true, and the value of *C* falls off as the temperature decreases.—R. W. Fenning: Gaseous combustion at medium pressures. Pts. i. and ii. Pressure-time records of the explosion of a complete combustion, carbon monoxide-air mixture with additions of (a) hydrogen-air and (b) water vapour, give records identical with those produced by (1) carbon monoxide-air plus 1.2 per cent. of water vapour, (2) carbon monoxide-air plus 2.1 per cent. of hydrogen-air (nearly dry). Closed-vessel explosions of methane-air mixtures were also investigated, the initial temperatures ranging from 24° C. to 400° C., and the initial pressures from 30 lb. to 171 lb. per square inch. For a mixture

containing 9.9 per cent. of methane, the explosion-time was increased by (1) increasing the charge density, (2) reducing the initial temperature, and (3) adding a diluent such as combustion products or water vapour.—R. K. Schofield and E. K. Rideal: The kinetic theory of surface films. Pt. ii. In Pt. i. it was shown in the case of dilute aqueous solutions of the fatty acids C_4 – C_8 , that the ratio FA/RT (where $A = 1/T$ is the area occupied by a gram molecule of fatty acid in the film) is not unity, but varies with F in a manner completely analogous to the variation of pV/RT with p for real gases. FA/RT , F curves for surface films of the sparingly soluble fatty acids C_8 , C_{10} , and C_{12} on dilute hydrochloric acid have been constructed from the surface tension-concentration data of Frumkin. At high-surface pressures the curves are straight, and thus (like those for the lower acids) conform to the two-dimensional Amagat equation $F(A-B) = \pi RT$. At low-surface pressures the curves, though essentially similar, do not correspond exactly with those of fluids. This is attributed partly to the molecules in the film having two distinct parts with different cohesions, and partly to the elongated shape of the molecules, which become inclined to the plane of the interface when in the act of separating from one another, thus causing the critical area to increase with the length of the hydrocarbon chain.—H. B. Dixon and G. Greenwood: On the velocity of sound in mixtures of gases. The method adopted was by comparing the dust-figures produced in a standard gas and those in the mixture by the resonance set up in two similar tubes. The results obtained (i.) in mixtures of gases of different density, (ii.) in mixtures of gases of the same density, are in close accord with the theoretical values calculated from the density of the mixtures and the specific heats of their constituents.—A. Fage and L. F. G. Simmons: An investigation of the air-flow pattern in the wake of an aerofoil of finite span. The vorticity is distributed over an area forming a band roughly parallel to the plane and ending in regions approximately opposite the tips, where the intensity is high. Farther behind the aerofoil, the band disappears from the central part, and at about 13 chords away the vortex system resolves itself into two localised areas. In front of the aerofoil, and beyond each wing tip, the flow is irrotational. Over each of the planes of exploration behind the aerofoil, the velocity is sensibly uniform.—W. L. Webster: Magnetostriction in iron crystals. For the (1, 0, 0) axis there is an increase in length for all values of the magnetisation; for the (1, 1, 0) axis there is an initial increase in length, followed by a contraction as magnetic saturation is approached; for the (1, 1, 1) axis there is a continual contraction. A combination of these effects seems to explain the results for soft iron, which are similar to those for the (1, 1, 0) axis. The effect of stress on magnetisation in the same rods is measured, and the results applied to a thermodynamically obtained, reciprocal relation between magnetostriction and the effect of stress on magnetisation. The agreement is satisfactory.—R. W. James and W. A. Wood: The crystal structure of barytes, celestine and anglesite. The structures of the isomorphous sulphates of barium, strontium and lead are all very similar. The structure is based on a simple orthorhombic lattice having four molecules to the unit cell, and the space group is V_h^{16} . The positions of the atoms have been determined by a study of intensities. In calculating the structure factors, the figures for the diffracting power of ions at different angles calculated by Hartree have been employed with slight modifications. The absolute intensity of reflection observed is lower than, although

of the same order of magnitude as, that calculated on the classical theory.—O. Maass and J. H. Mennie: Aberrations from the ideal gas laws in systems of one and two components.—R. G. Lunn: Fluid resistance to moving spheres. A large number of measurements of the times of fall of spheres, differing in size and density, through distances varying from 3 to 538 metres, in coal-mine shafts and other places, have been made. The resistance of air is calculated, and the way in which resistance depends upon velocity and acceleration for any sphere in linear motion is deduced. The range of velocity is such that the values of the Reynolds number are in the critical region ($10^4 < R < 10^6$), in which the resistance to uniform motion is proportional first to a power higher than the second, and later to a lower power. The effect of acceleration is to accentuate the rapid change in the resistant coefficient ($F/\rho V^2 d^2$). An application of the theory of dimensions suggests that the fluid resistance may depend not only upon velocity and acceleration, but also upon the rate of change of the acceleration.—W. G. Palmer: The adsorptive equilibria of binary gaseous mixtures. The method of the "coherer" is now applied to the determination of the composition of films containing two gases in adsorptive equilibrium with mixtures of the gases. The present application leads to a purely empirical method. The hypothesis that gaseous films are commonly only one molecule thick is corroborated. Examples of the following cases are given: (1) each gas competes equally for all the spaces on the surface; (2) a complex containing both gaseous molecules is formed, and acts as a single unit on the surface; (3) one gas is adsorbed only on specific areas of the surface. The method is rapid and should form a useful adjunct to investigations of catalytic actions upon solid surfaces.—I. Sandeman: The secondary spectrum of hydrogen at higher pressures. (ii.) A P and an R series have been selected, fitting along with Richardson and Tanaka's 83Q into a P, Q, and R combination, and closely conforming with the combination principle. This band is one of four bands the null lines of which are given by the Rydberg formula:

$$18567.47 - \frac{109678.3}{(n + 0.159883)^2}$$

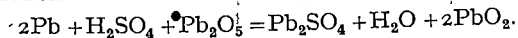
where n takes the values 6, 7, 8, and 9. Indications have also been obtained of a band corresponding to the integer 10.—P. A. M. Dirac: The fundamental equations of quantum mechanics. The paper is a development of Heisenberg's work on a new quantum significance of kinematic and mechanical relations. It is assumed that the equations of motion of a multiply periodic dynamical system can be taken over as they stand into the quantum theory, but that special mathematical operations must be used for interpreting them, which are such that the different solutions of the equations of motion are all interlocked and cannot be considered separately. Any variable x is taken to be represented by harmonic components of the form $x(nm) \exp. i\omega(nm)t$, where n and m refer to two stationary states or two sets of quantum numbers, and the frequencies $\omega(nm)$ satisfy the relation $\omega(nm) + \omega(mk) = \omega(nk)$. The product of two variables x and y has the amplitudes of its components determined by the equation $xy(nm) = \sum_k x(nk) y(km)$. Multiplication is thus not commutative, but except for this the algebraic laws are the usual ones. Certain quantum conditions are necessary to complete the solution of the mechanical problem. It is shown that the energy is the same function of the action variables as on Bohr's theory, and Bohr's relation between the frequencies and energy levels is deduced.

Royal Meteorological Society, November 11.—C. G. Abbot: Measuring sun rays. Solar radiation measurements are made by the Smithsonian Institution on two desert mountains in Chile and Arizona, and by estimating the losses due to the earth's atmosphere, the "solar constant" or radiation in free space at the earth's mean distance is determined. The average value of the solar constant is now known to within much less than 1 per cent. The determinations show two sorts of variation, one with a range of 2 per cent. associated with the sunspot cycle, and the other of short and irregular interval ranging up to an extreme magnitude of at least 5 per cent. The latter variations also are associated with the passage of sunspots across the sun's disc, the radiation decreasing when the spot reaches a central position. About ten years ago, Mr. H. H. Clayton began to investigate the weather changes associated with these apparent solar changes. Since December 1918 official weekly forecasts of temperature and rainfall have been issued by the Argentine Government, but the accuracy is not yet great. The solar radiation observations are responsible for some of the errors, and the Argentine Government has recently equipped its own observatory at La Quiaca. Mr. Clayton is now making experimental forecasts for New York, three, four, five days ahead, for the day, week, and month, and the forecasts are steadily improving. The National Geographical Society of the United States has made a grant to establish a third solar radiation station in the eastern hemisphere, with the view of improving the solar radiation observations. The requirements are a stable government, ready means of communication, cloudless skies, and a high altitude, and Dr. Abbot is to examine possible localities in south-west Algeria, north-east Baluchistan, and south-west Africa.

PARIS.

Academy of Sciences, November 3.—H. Deslandres: The progress made in the study of the sun at Meudon Observatory.—A. Béhal: The sixth International Conference of Pure and Applied Chemistry.—V. Grignard and J. Savard: The constitution of pulegone, the tertiary alkylpulegols and the alkylpulegenes.—Romanovsky: A method of interpolation of Tcheycheff.—G. Foëx and J. Kampé de Fériet: The application of photography on a moving plate to the study of the movement of projectiles, especially to the measurement of their velocity.—E. Esclangon: Measurements relating to the values of g at Paris and at Strasbourg. These experiments were carried out during the years 1922–1925 with the view of making the University of Strasbourg a new comparison centre. Use was made of a Deffonges pendulum oscillating in a vacuum, and incidentally it was noted that the effect of temperature on the period of oscillation could not be entirely accounted for by the resulting changes in the length of the pendulum. Variation in the elasticity of the knife-edges and suspension planes and in the coefficients of friction with temperature also produce effects to be considered.—A. Dauvillier: New researches on the Crookes' tube. Experimental studies on the disappearance of gas in the Crookes' tube and on the dark space.—C. Chilowsky and F. Perrin: A new method of distinguishing between natural pearls and cultivated pearls. In the natural pearl the layers are spherical and concentric, but in the cultivated pearl they are approximately plane. The method proposed consists in drilling a fine hole through the pearl and strongly illuminating the interior by means of a minute mirror: the natural pearl appears uniformly

illuminated whilst the cultivated pearl shows striae.—C. Féry and C. Chéneveau: The secondary reaction in the discharge of the lead accumulator. A new theory of the action of the secondary battery has been suggested by one of the authors based on the reversible reaction



In the present note an attempt has been made to measure experimentally the variations in the weights of the plates during charge and discharge. The results are in marked disagreement with the usually accepted theory and are nearer those predicted by the above equation, but the differences are such as to suggest that there is a secondary reaction taking place. A possible secondary reaction is indicated.—Pierre Jolibois: Methods permitting the study of the chemical effects of the electric spark on gases at low pressure. The apparatus described and figured permits the measurement of the energy of the spark and the change of pressure produced in the gas under examination.—A. Girard and E. Fourneau: A new method of great sensibility for the detection, separation and estimation of bismuth. If a benzene solution of tetracetylammmonium hydrate is shaken up with an aqueous solution containing potassium iodide and a trace of bismuth, a complex red compound is formed which is soluble in the benzene layer. A quarter of a microgram can be detected. The preparation of the reagent and mode of working will be described in a future communication.—Emile André and Henri Canal: Contribution to the study of the oils of marine animals. Squalene and spinacene. The oil from *Cetorhinus maximus* gave a well-crystallised chlorhydrate which proved on fractional crystallisation from acetone to contain two different products. The oil from *Scymnus hcha* behaved in a similar manner. The conclusion is drawn that squalene and spinacene are not definite chemical compounds.—Louis Longchambon: Cristobalite.—Fromaget: The extension and affinities of the fossil fauna of Indo-China.—Jean Motte: The cytology of the mosses.—F. Henrijean: The genesis of the rhythmic contraction of the heart.—L. Fage: Forms of the polychetal annelids.—René Fabre: Contribution to the study of hæmatoporphyrin. The application of the spectrophotometer to the determination of the distribution of the intensity in the fluorescence spectrum. Curves are given which may be utilised for the direct determination of hæmatoporphyrin.—L. M. Bétancès and J. de Luna: The rôle of the lymphocytes and granulocytes in the reparation of wounded tissues in the crayfish.—H. Guillemard: Azotemia in the course of mountain sickness. The experiments described indicate that there is a notable accumulation of non-proteid nitrogenous substances in human blood during the crisis of mountain sickness.—J. Duclaux and P. Jeantet: The transparency of natural waters to the ultra-violet rays.

Official Publications Received.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 271: Topography: Aerial Survey of the Mississippi River Delta. By G. C. Mattison. (Special Publication No. 105.) Pp. 16+9 plates. (Washington: Government Printing Office.) 10 cents.
Transactions of the Edinburgh Geological Society. Vol. 11, Part 3. Pp. 271-424+vi+plates 26-40. (Edinburgh.) 7s. 6d.
Records of the Geological Survey of India. Vol. 57: Quinquennial Review of the Mineral Production of India for the Years 1919 to 1923. By the Director and Senior Officers of the Geological Survey of India. Pp. vii+898+lxix+5 plates. (Calcutta: Government of India Central Publication Branch.) 5.10 rupees; 9s. 3d.
Proceedings of the Edinburgh Mathematical Society. Vol. 43 (Session 1924-25), Part 2. Edited by Dr. T. M. MacRobert and Prof. H. W. Turnbull. Pp. 85-145+vi. (London: G. Bell and Sons, Ltd.) 5s. net

The Royal Technical College, Glasgow. Annual Report on the One Hundred and Twenty-ninth Session adopted at the Annual Meeting of Governors held on the 20th October 1925. Pp. 81. (Glasgow.)

Ceylon Journal of Science. Section G: Archaeology, Ethnology, etc. Vol. 1, Part 2, October 1st. Edited by A. M. Hocart. Pp. 18-80+plates 9-31. (Colombo: The Archaeological Commissioner; London: Dulau and Co., Ltd.) 3.5 rupees.

United States Department of Agriculture. Department Circular 364: The Color Grading of Honey. By E. L. Seagrist. Pp. 8. 5 cents. Department Bulletin No. 1355: Food Habits of the Vireos, a Family of Insectivorous Birds. By Edward A. Chapin. Pp. 44. 10 cents. Department Bulletin No. 1350: Blue-Fox Farming in Alaska. By Frank G. Ashbrook and Ernest P. Walker. Pp. 35. 10 cents. (Washington: Government Printing Office.)

The Origin and Antiquity of the American Indian. By Aleš Hrdlička. From the Smithsonian Report for 1923. (Publication 2778.) Pp. 481-494+17 plates. (Washington: Government Printing Office.)

Diary of Societies.

FRIDAY, DECEMBER 11.

MANCHESTER ASSOCIATION OF ENGINEERS (at the Engineers' Club, Albert Square), at 7.15.—A. P. M. Fleming: Physics and Engineering. RAILWAY CLUB (at 65 Belgrave Road, S.W.1), at 7.30.—J. R. Hind: Some Little-known Features of Railway Publicity.

SATURDAY, DECEMBER 12.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, at 3.—J. T. Pringle: The Housing of Workmen. INSTITUTE OF TRANSPORT (North-Eastern Local Section) (at the Town Hall, Newcastle-upon-Tyne), at 3.—R. C. Mayes: The Organisation and Working of the Royal Victoria and Albert, and King George V. Docks of the Port of London Authority. INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at the College of Technology, Manchester), at 7.—J. S. G. Primrose: The Physical Testing of Foundry Products. HULL ASSOCIATION OF ENGINEERS (at the Technical College, Hull), at 7.15.—D. Weir: Rolling Mills and the Manufacture of a 40,000 kv.-a. Turbo-Alternator (Lecture).

MONDAY, DECEMBER 14.

ROYAL IRISH ACADEMY, at 4.15. ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Prof. L. W. Collet: The Alps and Wegener's Theory. ROYAL SOCIETY OF MEDICINE, at 5.—Surg.-Comdr. J. L. Priston: The Prevention of Scurvy in the Royal Navy. INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—E. H. Shaughnessy: Post Office Wireless Stations. INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Lt.-Col. K. G. Maxwell and A. Monkhouse: Recent Improvements in the Insulation of Electrical Machinery. INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 7.—V. F. Cornish: Mechanical Transmission of Power on Electric Locomotives. INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Chamber of Commerce), at 7.—W. Ferrier Brown: Sleeve-Valve Engine Development. INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30. INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Dr. H. Hyman: Aluminium and its Alloys as used for Engineering Purposes. ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. J. L. Stocks: The Unity of Thought. MEDICAL SOCIETY OF LONDON, at 8.30.—C. A. R. Nitch and others: Discussion on The Treatment of Genito-urinary Tuberculosis.

TUESDAY, DECEMBER 15.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—Sir R. H. Rew: The International Statistical Institute and its 16th Session. INSTITUTION OF CIVIL ENGINEERS, at 6.—A. Honeysett: Pressure-Boosting Station for the Waterworks of the City of Monte Video. INSTITUTE OF MARINE ENGINEERS (at 85-88 The Minories), at 6.—J. A. Sim: Economic Application of the Scott-Still Engine. INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Prof. S. P. Smith: An All-Electric House. ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. H. Featherstone: Home Kinesmatography with the Baby Ciné-Camera and Projector. INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Otto Kahrs: The Economic Value of Bunker Coal. ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Capt. Pitt-Rivers: The Inhabitants of Ana Island. BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Society of Arts), at 8.15.—Sir Frederick Pollock, Bart.: Do we need a Philosophy of Law in England?

WEDNESDAY, DECEMBER 16.

SOCIETY OF GLASS TECHNOLOGY (London Meeting) (in the Chemistry Lecture Theatre, University College), at 2.30.—Prof. W. E. S. Turner: The Composition of Glass suitable for Use in Automatic Machines.—Violet Dimbleby and Prof. W. E. S. Turner: The Relationship between Chemical Composition and the Durability of Glass.

ROYAL METEOROLOGICAL SOCIETY, at 5.—I. D. Margary: The Marsham Phenological Record in Norfolk, 1736-1923, and some others.—C. D. Stewart: Experiments on the Shielding of Raingauges.—Dr. H. Jeffreys: On the Dynamics of Geostrophic Winds.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. W. D. Lang and Dr. L. F. Spath: The Black Marl of Black Ven and Stonebarrow in the Lias of the Dorset Coast.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers) (Annual General Meeting), at 6.—D. Sinclair: Some Facts and Notions about Short Waves.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—Sir C. R. S. Kirkpatrick: The Development of Harbour and Dock Engineering (Lecture).

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 15 Savoy Street, Strand), at 7.—A Report on Progress in Electric Lamps and Lighting Appliances.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates' Meeting) (at Chamber of Commerce), at 7.30.—F. G. E. Clarke: Press Tools.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Watgate House, Adelphi) (Graduates' Meeting), at 7.30.—C. A. Edwards: Sales and Service.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB (at Glasgow University), at 7.30.—Prof. E. P. Cathcart: Problems of Metabolism.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Dr. W. Cramer and Dr. R. J. Ludford: Bile Canaliculi and the Golgi Apparatus in Hepatic Cells.—Dr. C. De Fano: Recent Methods for the Study of the Neuroglia.—Miss A. Lorrain Smith: Some Lichen Dyes.—F. I. G. Rawlins: The Theory of Dimensions in Microscopy.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at the Royal Society of Medicine, 1 Wimpole Street), at 8.30.—Dr. J. Glover: Divergent Tendencies in Psychotherapy.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—Prof. J. S. Huxley: The Courtship of Animals and the Present Position of the Sexual Selection Theory.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group, jointly with Nottingham Section) (at Nottingham).—R. G. Parker and D. N. Jackman: Some Effects of Humidity on the Properties of Fabrics, with Special Reference to the Control of Humidity during Strength Tests.—Dr. E. B. R. Prideaux and E. C. Roper: The Analysis of Commercial Bifluorides.

INSTITUTION OF STRUCTURAL ENGINEERS (Lancashire and Cheshire Branch) (Students' Evening).—J. L. Manson: Factors in the Development of Structural Practice.

THURSDAY, DECEMBER 17.

LINNEAN SOCIETY OF LONDON, at 5.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Dr. H. S. Hele-Shaw and T. E. Beacham: A New Form of Air-Compressor.—A. Livingstone Oke: Notes on Diamond Prospecting, Gold Coast Colony.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—C. E. Webb: The Power Losses in Magnetic Sheet Material at High Flux Densities.

ROYAL AERONAUTICAL SOCIETY, at 6.—Informal Discussion on Aero-engine Starting Gear.

CHEMICAL SOCIETY (Informal Meeting), at 8.

INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (London), at 8.—Discussion on Regulations of the Institute.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, Cavendish Square), at 8.15.—Sir T. C. Evans: The Surgical Aspects of Amoebiasis.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children and Dermatology Sections), at 8.30.—Discussion on The Aetiology and Treatment of Infantile Eczema.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Branch) (at Birmingham).—H. F. L. Orcutt: Characteristics and Uses of Ground & Gears.

FRIDAY, DECEMBER 18.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—Dr. W. Clayton: Coagulation and Flocculation in Colloid Systems, with Special Reference to Industrial Problems.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), 7.—Discussion on The Work of the Mechanical Engineer in Non-Engineering Industries, introduced by W. P. F. Fanghanel.

JUNIOR INSTITUTION OF ENGINEERS, at 7.—Lecture and Demonstration of Industrial and Domestic Electric Lighting at the Demonstration Rooms of the Lighting Service Bureau.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—Members' Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. L. Emanuel: An Artist's Remarks on some Old Photographs.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.30.—Prof. T. H. Havelock: Some Aspects of the Theory of Ship Waves and Wave Resistance.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE (in the Royal Technical College, Glasgow).—L. Rothera: Speed Control in Relation to Modern Rolling Mill Drives.

SATURDAY, DECEMBER 19.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle-upon-Tyne), at 2.30.

PUBLIC LECTURES.

SATURDAY, DECEMBER 12.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. G. Cannon: Floating Life in the Sea.

MONDAY, DECEMBER 14.

DYERS' HALL (Dowgate Hill, E.C.), at 6.—Prof. G. T. Morgan: Recent Researches on Mordant Dyes.



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The Highway to the University.¹

THE report on the accessibility of university education to poor students prepared by Mr. G. S. M. Ellis for the Stapley Trust, for which Lord Haldane has written an appreciative foreword, reopens an ancient controversy on a basis of modern needs. The author's case, reduced to its bare bones, is that the percentage of the population of England educated at a university is far behind that of Scotland or Wales; that the wider opportunities in Wales and Scotland are reflected in the larger numbers of pupils from elementary schools who reach the university; and that the scholarships offered by local education authorities in aid of university education in England are inadequate in number and, on the average, insufficient in amount.

The remedy proposed is that a uniform minimum provision of university scholarships should be made a statutory obligation on all local education authorities. Incidentally, the author criticises severely the Board of Education for neglecting to bring up-to-date statistics of scholarships such as were supplied for 1911-12 to the Royal Commission on the Civil Service, and published in 1914. The author apparently had not seen, before his booklet went through the press, the recently published Statement of Expenditure on Maintenance Allowance Awards incurred by local education authorities in 1923-24 (Cmd. 2415). It would have warned him of the unreliability of any conclusions drawn from the figures of 1911-12 being applicable to the conditions of 1924-25. The limitation also of the report to one—though no doubt the largest—source of supply of scholarships, namely, those offered by local education authorities, makes impossible any kind of estimate of the adequacy or inadequacy of the supply as a whole. A general review, however, is a task for the Board of Education, and not for an individual worker. The most valuable part of the author's case is that he has shown the pressing need for such a survey.

Mr. Ellis calculates that 21 per 10,000 of the Scottish population were full-time university students in 1922-1923, the figures for Wales and England being 12 and 8 respectively. The actual numbers were 27,994 (England), 2650 (Wales), and 10,294 (Scotland). It is long since Scotland acquired the university-going habit. It was the outcome in the past of the excellence of her parish schools, of inexpensive university education, of the inducement of hundreds of small university bursaries, of parental sacrifice, and, above all, of the fact that to poor and able Scottish youths the university became the gateway to the world. In more recent days, the extended provision of secondary school education

¹ "The Poor Student and the University." By G. S. M. Ellis. Pp. xi + 60. (London: The Labour Publishing Co., Ltd., 1925.) 2s. 6d. net.

and assistance from the Carnegie Fund, have strengthened the traditions of earlier generations. A telling example comes from the Hebrides. The island of Lewis has a population of 28,000 persons, 4000 of them in the town of Stornoway. In 1894 the Nicolson Institute in that town was a small elementary school of 256 pupils with a handful of ex-standard children included. The newly appointed headmaster organised a secondary course, and a few school bursaries were made available from county funds to bring in the landward children. Four years later the school sent its first two students direct to the university.

The same headmaster, about to retire, reports a roll of 400 secondary school pupils (half from country districts), and that in the interval the school has sent 250 boys to the university and 240 girls to training colleges for teachers. These students were the sons and daughters of townsmen, crofters, and fishermen, with here and there one from the schoolhouse or the manse. The maintenance bursaries at the school vary from 5*l.* to 24*l.* About 180 country pupils are living in lodgings. That number includes 50 girls in the hostel provided three years ago by the Carnegie United Kingdom Trust (charge, 12*s.* per week). The county (university) bursaries, in any individual case, do not exceed 30*l.*, to which may be added the Carnegie fees grant of 9*l.* A few of these scholars hold in addition a small bursary from the Highland Trust or other granting body. The balance of the cost is made up in many cases with much effort and self-denial on the part of parents, brothers, and sisters. It is often a family concern, with uncles and aunts and cousins also helping. The old students of that school are so much scattered over the globe that a much-travelled Scot who has an intimate knowledge of it said recently that the island of Lewis was the most cosmopolitan rural area in Great Britain.

Until two generations ago, higher education in England was the privilege of the middle and upper classes. But the progress made in the present century has been remarkable. By the end of last century the School Boards had done their work of providing elementary schools and getting the children into them. The Education Acts of 1902-3 empowered the new authorities to supply or aid higher education and to organise a system by means of which pupils might pass from the elementary schools to the secondary, and from these to the university. In 1904-5 there were 95,000 pupils in secondary schools in England and Wales: twenty years later the number in schools on the grant list had risen to 359,000. Since 1914 the figures have been doubled. The Board of Education estimates (Report, 1923-24) that in 1900, 5500 children were being assisted to proceed from elementary to secondary schools;

to-day the free places in secondary schools on the grant list number 110,000, 36 per cent. of the total. Moreover, the school life is lengthening; the proportion of pupils above eighteen years of age is steadily growing, and the candidates for the higher school certificate examinations are increasing annually at a great pace. In the present year the number reached 5000: six years ago it was only 2000. The number of university scholarships awarded in 1911-12 was 464, the total maintained at universities in that year being 1327, the average value 43*l.*, and the total 57,000*l.* Mr. Trevelyan stated in the House of Commons in April 1924 that in the year 1922-23 the local education authorities had expended 220,000*l.* in scholarships to universities and other institutions of university rank. We now learn from the Statement of Expenditure (Cmd. 2415) incurred by local education authorities in maintenance allowances under Grant Regulations No. 14, that allowances of 127,000*l.* were made to undergraduates in 1923-24, the number of awards being 2756, while other awards to technical colleges and other institutions of university rank amounted to 81,594*l.* Lastly, whereas in 1908-9 695 boys and 361 girls proceeded to a university from grant-earning schools in England and Wales, by 1920-21 the numbers had risen to 1674 boys and 1214 girls, nearly three times as many. In the former year one-third of the schools contributed; in the latter, two-thirds.

This array of figures does not prove that the number and value of scholarships in 1924-25 are greater than they were in 1911-12. But it does suggest with certainty that a profound change has been effected, and that it would be unwise to frame any policy on figures so completely out-of-date as those of 1911-12. The splendid record of the progressive authorities must not, however, be allowed to hide the parsimonious attitude of a good many others whose contributions to university education are nil or negligible. In this connexion, one of Mr. Ellis's subsidiary points deserves greater attention than it usually gets: the possibility of higher education has come to depend overmuch on accidents of birthplace and residence, and the exact position of the county or borough boundary has assumed a fortuitous and unreasonable importance.

Space forbids much further consideration of this very interesting pamphlet. "Obviously," says the author, "the provision of scholarships does not meet the national need for trained men and women." Again, "it would be difficult to maintain that only this small percentage (0.73) of elementary school boys and girls who reach the university has outstanding ability." The crux of the problem is the bringing together of ability and opportunity. The concern in the homes of poor students is with the opportunities that follow a

university course. Here is a task for the Appointments Boards, which have already done much to facilitate the process of getting graduates placed. When conditions become such that a high percentage of honours graduates has little difficulty in obtaining posts with reasonable prospects, the story of such successes will soon reach the schools, and there will be no lack of graduates of "outstanding ability." The desire to reach the university will then react on the scholarship system and help to expand it.

The road to the university is not, however, the only outlet to the poor student. Among others, some attention might have been given to the technical colleges which provide full-time three-year courses for 4500 students.

Radioactivity and Geology.

The Surface-History of the Earth. By Dr. John Joly.

Pp. 192 + 9 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1925.) 8s. 6d. net.

IN this brilliant and stimulating book, Prof. Joly has conveniently brought together the results of many years' work and thought on the radioactivity of the rocks. Its central theme is an illuminating hypothesis, according to which the radioactivity of the rocks has been the dominant influence in controlling geological history. The search for adequate causes and convincing explanations is beginning to be rewarded, and theoretical geology need no longer grope in a maze, albeit a fascinating one, of unco-ordinated observations. Prof. Joly's inspired originality should henceforward lead geology into a new phase, the more mature phase that lies beyond the initial observations and their classification.

The present Lord Rayleigh's pioneer work on the distribution of radium in rocks showed nearly twenty years ago that the earth must gain from radiothermal energy at least as much heat as it is losing by radiation into space. It was difficult, indeed, to believe that the earth was not actually growing hotter. In 1921 Lord Rayleigh again expressed the guarded opinion that the internal temperatures should be rising, but he added, "we are puzzled to explain the existing state of things" (NATURE, October 27, 1921, p. 280). In 1915 the present writer elaborated a cooling hypothesis that has since been widely adopted, involving a distribution of the radioactive elements that permitted the earth to have cooled from a molten state since the beginning of geological time, and allowed for internal temperatures that were thought to be adequate to explain vulcanism. Further consideration of the implications of this hypothesis have led to its abandonment for the sufficient reason that they were found to be in contradiction with

the known facts of geological history. It should be said, however, that Dr. Harold Jeffreys still considers that any departure from this hypothesis in the direction of admitting more radioactivity leads to consequences that flatly disagree with observations. Apparently it is as impossible to believe that the earth is cooling as it is to believe that the earth is not cooling.

A way out of the impasse has been found by Prof. Joly. He persuades us to believe that both heating and cooling have taken place. There would be a touch of Irish humour here, were it not that the two processes do not occur at the same time. They alternate; and in the alternation lies a clue to the cause of the mysterious heavings and crumplings that have periodically affected the outer shell of the earth.

From the known data of seismology, and the well-established theory of isostasy, Prof. Joly concludes that the continents are essentially composed of granitic rocks having a thickness of about 32 km., and a density of about 2.67; and further, that they are submerged in a deep substratum of basaltic composition which rises around them to form the ocean floor, and has a density when solid of about 3.0. The materials of the continents and the substratum respectively are supposed to contain substantially the same proportions of the radio-elements as actual specimens of them, represented by granites and basalts from various parts of the globe. From the data adopted, and there seems here to be no possible flaw, the temperature at the base of the continents is easily calculated to be approximately that of the fusion-point of basalt, while the heat emitted is equivalent to that lost from the surface of the lands by radiation. It follows from this that the heat generated in the underlying basaltic layer by the radio-elements must accumulate; and since the substratum is solid at the present day, it evidently lacks only latent heat to become fluid. In about forty million years it must become so throughout. Similarly, at and below a certain depth beneath the ocean floor, the substratum must also pass sooner or later into a fluid condition.

Geological time is to be measured in at least hundreds of millions of years, and consequently this accumulation of latent heat in basalt must have occurred in the past; and as the substratum is now solid, the excess of heat must in some way have been dissipated. Tidal action is ingeniously invoked to provide a mechanism whereby the accumulated heat can be for the most part harmlessly discharged into the oceans. When widespread fusion supervenes, a slow westerly drift of the still solid crust begins, and the deep, possibly superheated magma formed beneath a continent thus comes to underlie the ocean floor to the east. The ocean floor is then stopped and melted away from below, until the upward loss of heat by conduction becomes sufficiently rapid to bring

the process to an end. Widespread consolidation is promoted by convection currents, and owing to the sinking of stoped-down blocks and newly formed crystals, solidification develops from below upwards. Finally, the lateral movement is brought to a standstill by the grounding of the continental roots on a solid foundation. Each level of the substratum is thus left at the end of the cycle at a temperature that must be that of its solidifying point, or a little lower, at the pressure there obtaining.

Tectonic and igneous processes are obviously facilitated by the changing volume and changing state of the substratum. The overlying crust becomes heaved up as fusion progresses, but the continents sink a little relatively to the oceans, and transgressional seas advance over the lands. Continents and ocean floor are now under tension, and basaltic magma squeezes through the cracks, healing the ocean floor and preventing its wholesale subsidence into the depths, and giving rise to vulcanism on a large scale such as broke out in early Tertiary times in the Deccan and Brito-Arctic provinces. Present-day vulcanism is of a different nature altogether, being a consequence of the ascent of hot gases from magmas now in the later stages of crystallisation.

When the expansion due to the growth of the magma is at its maximum, the area of the surface is greatly increased, and when consolidation sets in, the increased area has to settle down on the contracting substratum. Where the margins of the continents have been weakened by the filling of bordering geosynclines with sediment, they become deformed by folding and overthrusting due to the resulting compression. The seas withdraw as the lands begin to rise again, and finally isostatic adjustments complete the orogenic processes, and the newly folded mountains rise in proportion to the depths of their roots.

In broad outline, the ideal cycle of events thus briefly sketched can be matched several times over by the actual sequence of events in geological history. In detail, a simple repetition of the cycle is quantitatively insufficient. Prof. Joly acknowledges only three complete cycles since the Charnian orogenesis of the late pre-Cambrian, terminating in turn in the Caledonian, Hercynian, and Alpine movements. The Laramide of America is thought perhaps to imply a fourth. The writer has found that the evidence suggests a list of five times as many cycles since the pre-Cambrian; some involving merely subsidence and emergence; others being accompanied by moderate folding; and a few, the great "revolutions" of Prof. Joly, being marked by overthrusting to a degree that would be mechanically incredible had it not indubitably occurred. Such a striking variation in intensity seems to imply not only

the expansion and contraction of the basaltic layer alone, but also the superimposed effects of underlying layers which may reasonably be expected to be less radioactive.

The different interpretation to which attention is here directed may be tested with reference to geological time. It is well known that Prof. Joly favours the smaller estimates of time, such as that based upon the supply of sodium to the oceans. He also believes from the evidence of pleochroic haloes that uranium may have disintegrated very much more rapidly in the past, and for this reason that certain thorium minerals may give more reliable lead-ratios than uraninites. The chapter in which these matters are dealt with is distinctly provocative and certainly unsatisfactory. The sodium method has really no bearing on the question at all, for the data that have been employed are both faulty in themselves and contradictory in their implications. Some thorium minerals (such as the thorianites of Ceylon) give the same lead-ratios as the associated uranium minerals, and it seems unfair to pick out the smaller results as being better than the larger. The atomic weight of lead from radioactive minerals definitely suggests that uranium has decayed at the same or nearly the same rate throughout geological time. The anomalies of pleochroic haloes can be explained in at least two other ways besides the one favoured by Prof. Joly, and all three must remain speculative until we know more of the complexity of "uranium" and the origin of actinium. The reviewer can find no reason to believe that the lead-ratios of uranium minerals may be "four times too high." At the worst it is improbable that they should be in error by more than 10 per cent.

Prof. Joly's application of his hypothesis to earth movements implies three or four cycles of about 40 million years each, giving only 120 or 160 million years since the beginning of the Cambrian. But if the actual length of time is of the order 600 million years, as indicated by radioactive minerals, then there should have been many more cycles, as indeed there have. The more prominent mountain-building periods would then be due to the superimposed effects of the consolidation of a deeper-seated magma, such as that of peridotite. This presumably has gone through only a few cycles, each being of much longer period than those of the comparatively shallow basaltic substratum.

It must not be supposed that this difference of opinion in a matter of interpretation is intended to detract in any way from the value of Prof. Joly's far-reaching hypothesis. On the contrary, it illustrates in a remarkable way the fertility and all-embracing character of that hypothesis. Logically extended, and applied on a more detailed scale to the geological history it is

intended to elucidate, a still stronger case can be made out in its favour. Moreover, it renews interest in the principles of Wegener's displacement theory, for this can no longer be resisted on the grounds of permanent rigidity. It raises a substantial hope that in the lateral movements of the crust a solution may be found of the tantalising problems of the climates of the past. In the domain of igneous petrology it will prove invaluable by providing for the first time the possibility of a real genealogy of rocks. Already it has so much to its credit that it must be regarded as a contribution to geology of the highest rank.

The thorough assimilation of the contents of this book by all geologists is indispensable, and indeed every one who is at all interested in the behaviour of the earth should read it. The lucid style reveals the author at his best, and the book is easily readable, for technical matters of detail are relegated to the appendices that close many of the chapters. Finally, a word of praise is due to the publishers. They have made a book that is worthy of its subject and its author, beautifully printed and illustrated, and issued at a price which can only mean that they wished to encourage every geologist in the world to buy it.

ARTHUR HOLMES.

Electrical Precipitation: Natural and Artificial.

Electrical Precipitation: a Lecture delivered before the Institute of Physics. By Sir Oliver Lodge. (Physics in Industry, Vol. 3.) Pp. 40+5 plates. (London: Oxford University Press, 1925.) 2s. 6d. net.

CHEMISTRY has been defined as "the dirty past of physics." The electrical precipitation of dust from industrial gases, for example from producer gas, blast furnace gas and various gaseous products of chemical industry, is a dirty business. This may in part account for the fact that the subject is, so far as current English scientific literature is concerned, treated only in works on chemistry. The literature of physics is practically silent about the subject. No reference to it is found even in Glazebrook's "Dictionary of Applied Physics," and this even though the process is decidedly both applied and physical in character. This deficiency is now rectified by the appearance in book form of Sir Oliver Lodge's lecture on electrical precipitation delivered before the Institute of Physics, in which the subjects of natural and artificial precipitation of moisture, dust, etc., are discussed in a manner of which Sir Oliver almost alone would appear to possess the secret. His recent plea for a simplification of the language in which science seeks to deliver its message is here followed up by a glowing example of the manner in which this may be achieved.

The story of natural electrical precipitation as evidenced in thunderstorms is first told. In fine weather the average atmospheric positive potential gradient at the earth's surface is of the order of 100 volts per metre. The gradient diminishes with height, the potential assuming a practically constant value of about 1 million volts at a height of 10 kilometres. During a thunderstorm the vertical force at the ground frequently exceeds 10,000 volts per metre. An average flash of lightning has a length of 10 kilometres, and the energy liberated in the flash is equivalent to that acquired by a mass of 100 tons falling 650 yards.

The maintenance of the fine weather potential gradient in the atmosphere is one of the outstanding difficulties of meteorological physics. At least four theories, against each of which some objection can be sustained, have been proposed. As regards the origin of the potential gradients associated with thunderstorms, Simpson's theory proposed in 1909 is that most generally, though by no means universally, accepted. Simpson discovered the remarkable fact that the mere breaking-up of a drop by a current of air results in electrification. A large drop falling through air and breaking-up becomes positively charged, the air receiving a negative charge. Sooner or later the small ascending globules of water produced coalesce into larger drops and the cycle of operation is repeated, until the drops become so highly charged that they no longer combine and fall. They are then carried to a higher stratum and form part of an electrified cloud. This, very briefly, is Simpson's theory of the origin of a thundercloud. Prof. Armstrong, in explanation, brings in hydrone, forsooth! (NATURE, 1923, 112, 537, 827; 1924, 113, 124.) Is the hydrone theory helpful in explaining even the simplest experimental facts of electrolysis, for example, the phenomenon of visibly moving boundaries met with in the determination of "ionic velocities"?

Sir Oliver suggests that natural precipitation in the form of rain should be artificially assisted, whereby the "rain-makers" may be dispossessed of this field. We foresee trouble arising from matters relating to the degree of control to be exercised, and to the selection of one or more in whom the right to exercise this control is to be vested. Have we not heard of a Scotch divine who, on his prayer for rain being "answered" by an immediate and boisterous thunderstorm, exclaimed, "Oh, Lord, this is too ridiculous"?

A section on the precipitation of dust from gases on an industrial scale is contributed to the volume by Lionel Lodge. The idea of removing suspended particles from gas streams by means of electrical discharge would appear to have been originated by Hohlfield in Leipzig in 1824. Guitard revived the

subject in London about twenty-five years later. Sir Oliver Lodge and Mr. J. W. Clark in 1884 investigated the dust-free space in the neighbourhood of hot bodies—a phenomenon to which is attributed the blackening of walls, ceilings, etc., in the neighbourhood of gas flames and electric light bulbs (p. 24)—and suggested the use of an electrical discharge as a means of dissipating fog and smoke. In 1885, Messrs. Walker and Hutchings, in association with Lodge, attempted the commercial exploitation of the electrical cleansing of gases. In those days the methods of producing high-tension discharges were primitive, and the difficulties of securing efficient insulation were insufficiently appreciated. The attempt was ultimately abandoned.

The subject was revived by Cottrell in 1906 and the practicability of the system definitely established. The first successful commercial plant was erected by the Selby Smelting and Lead Company at San Francisco Bay. The Lodge and Cottrell financial interests were amalgamated by the formation of Lodge-Cottrell Limited, now working in friendly co-operation with the Metallbank u. Metallurgische Ges. A.-G. The scale of the operations may be gauged by reference to the first successful plant erected at Queen's Ferry by the Ministry of Munitions in connexion with a Gaillard sulphuric acid tower. Here about 64,000 cubic feet of gas at 80° C. flow per minute past the discharge and collecting electrodes and carry about 4 grains of SO₂ per cubic foot. The operating voltage is about 100,000 volts, and about 30 tons of sulphuric acid are recovered a day.

The practical difficulties have not as yet, in all cases, been overcome. There are troubles connected with the dislodgment of the deposited dust from the electrodes. The hygroscopic character of the dust introduces difficulties in some cases; the shape of the electrodes is of paramount importance in others. The plant is necessarily on a large scale. Thus a plant erected to operate in conjunction with a number of blast furnaces was, on account of its size, popularly known as "the cathedral." Even with plant on such a scale, difficulty was experienced in purifying the gases, originally containing 5 grams of dust per cubic metre, to such a degree as to render them fit for use in gas engines. However, progress is being made, and the process is nowadays applied in a variety of directions, there being about 200 plants operating in conjunction with plants for the recovery of products from acid fumes, waste gases from metallurgical processes, combustible gases and miscellaneous dusts. The average efficiency of the plants is such that about 95 per cent. of the dust content is deposited. Cleaning costs amount on the average to about 1s. per 100,000 cubic feet of gas treated.

J. S. G. THOMAS.

The Art and Life of Early Man.

Prehistory: a Study of Early Cultures in Europe and the Mediterranean Basin. By M. C. Burkitt. Second edition. Pp. xxvi+438+48 plates. (Cambridge: At the University Press, 1925.) 35s. net.

It is not surprising that Mr. Burkitt's treatise on prehistory should so soon have reached a second edition. It is a unique summary of the handicraft and art of the successive races of Palæolithic man in Europe, with some references to Neolithic and Bronze Age man. It is based on personal observation, guided by one of the foremost pioneers in such research, the Abbé Breuil. It is not only a clear statement of the facts in convenient order, but also a discussion of all the important inferences which may be drawn from these facts as to the life and ideas of primeval man. It is, indeed, both a work of reference and one which will satisfy the general reader who desires only a broad view of the subject.

The new edition is not much changed, only one chapter, that on "The Neolithic and Bronze Ages," having been largely rewritten. The author, however, mentions that he has taken note of various press criticisms, and he has made the book more useful by adding to the text references to the figures in the plates. He has also included a map of western Europe showing the position of the more important localities cited. The new frontispiece, representing the "sorcerer" in the cave of Trois Frères in southern France, is a striking addition. It is the figure of a man disguised by placing a stag's antlers on his head, drawn on the wall "dominating the situation beside the natural pulpit where no doubt the actual artist-medicine-man-priest performed." This and some other recent discoveries are specially mentioned in the preface prepared for this second edition.

The chief additions to the text are in short notes where space admits them at the end of each chapter. It is perhaps the simplest, but not altogether a satisfactory arrangement. The text itself still needs revision. The statement that "bone was first utilised in Upper Mousterian times" (p. 76) is contradicted by the reference to the bone implement from Piltdown (p. 89). A footnote on p. 94 has escaped notice. Some of the English construction could also be improved. The author does not mean what he says, for example, when he refers to heads which have been decapitated (p. 188); and there are other expressions which need some modification. These, however, are minor blemishes in a work which will continue to be indispensable to every student of prehistoric archaeology who would keep abreast of his subject.

A. S. W.

Our Bookshelf.

- (1) *Relativity: a very Elementary Exposition*. By Sir Oliver Lodge. Pp. iv+41. (London: Methuen and Co., Ltd., 1925.) 1s. net.
- (2) *Relativity, Meaning, and Motion*. By Claude G. Henderson. Pp. vi+111. (London: Watts and Co., 1925.) 3s. 6d. net.
- (3) *The Common Sense of the Theory of Relativity*. By Dr. Paul R. Heyl. Pp. 44. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1924.) 5s. net.
- (4) *La relativité dégagée d'hypothèses métaphysiques: exposé des théories d'Einstein, discussion de ces théories, essai d'une théorie nouvelle construite dans l'espace et le temps classiques*. Par H. Varcollier. Pp. xx+542 (Paris: Gauthier-Villars et Cie., 1925.) 50 francs.

(1) THIS short account of the theory of relativity was given as a lecture to the Literary and Philosophical Society of Liverpool in 1921. The book is—as the title states—a very elementary exposition. It is certainly hopeless to give a popular account which bears even the slightest resemblance to the theory of relativity without drawing on the concepts of ordinary life; and this essay is interesting to read because it shares with the other writings of Sir Oliver Lodge the agreeable characteristic of being filled with vivid illustrations from the everyday experience of the man in the street.

(2) Mr. Henderson's small book is designed for a popular audience, and it is unfortunately not unlike a large number of other books meant for the consumption of the general reader, in that the language and the treatment are frequently obscure. It is indeed difficult to know what useful purpose can be served by introducing the ideas of the theory of relativity into the discussion, on general non-technical lines, of questions such as "the nature of truth," "meaning," "the mind," and so on. The argument from analogy used with no regard for the niceties of problematical inference is a poor instrument.

(3) Prof. Heyl's essay on relativity breaks new ground in popular exposition. The plan is to give first a brief historical account of the development of the data relevant to the law of gravitation, and many interesting pieces of information are to be found in the opening chapters. The author gradually builds up, in the simplest language, the position of affairs before Einstein, and shows how the outstanding discrepancies were accounted for by the theory. This side of the book is good; but there is another side.

The author makes remarks, which may or may not be cryptic to the popular reader, about the "repelling appearance" of Einstein's theory and its "artificial nature," and he quotes the jejune observation that it is "repugnant to common sense."

Now it is undesirable to leave the erroneous impression in the mind of any reader that the theory of relativity is fundamentally artificial, however poor his knowledge of mathematics may be. For the nature of the postulates and the new and subtle appeal which they make to the scientifically developed common sense is the outstanding characteristic of the theory of relativity from the point of view of scientific method.

The notion of an "Invariance Postulate" is perfectly simple and can be explained to any intelligent person. This is the really important idea, and is what should be emphasised if an appeal to intuition and plausibility is to be made. There should therefore be an attempt to introduce it in a book which deals with the common sense of the theory of relativity.

(4) Prof. Varcollier's interesting volume should be very stimulating to the student of modern theories of world geometry and mechanics. The work is concerned with the exposition of the mathematical structure of relativity theory and with special interpretations of the results. Whatever may be the verdict on the interpretations, the very detailed account of the mathematical groundwork of modern mechanics should prove useful.

D. M. W.

Tabulae Anatomico-Comparativae Cerebri: a Series of Nine coloured Maps with Description. Edited by Dr. C. U. Ariëns Kappers. Descriptive Text. Pp. 30. Plates 44 in. $\times$ 31½ in. (Amsterdam: The "Kosmos" Publishing Co., 1925.) 20 U.S. dollars.

THE "Tabulae Anatomico-Comparativae Cerebri," edited by Dr. Ariëns Kappers, director of the Central Institute for Brain Research in Amsterdam, consist of a set of nine large coloured plates illustrating the comparative anatomy of the brain and spinal cord. Two of these charts are before us.

The central nervous systems of Acrania, cyclostomes, selachians, teleosts, amphibia, reptiles, birds, marsupials, and primates (man) are to be exemplified by those of certain carefully selected types. The different nuclei and the chief fibre systems are all so represented in different colours that the comparative arrangement of any part of the central nervous system can be recognised at a glance. As the various parts of the central system are represented in sagittal projection, the nuclei and the tracts are all reduced to one plane, and for the sake of clarity some freedom in drawing has been necessary.

The chief interest in the series centres in the evolutionary changes whereby the human brain is the outcome. It is to be made apparent that in the human brain the thalamus proper, and more especially the dorsal thalamus, have undergone striking increase, whereas the tonic and autonomic striatum has increased but slightly. The pallial centres of sensory, visual, acoustic, and olfactory projections, regarding them as a whole, have not increased so much as the centres of correlative functions, which depend not only on inter-cortical systems but also on connexions with sub-cortical nuclei. For example, the increase of the frontal is chiefly associated with the increase of rubro-frontal projections and the appearance of fronto-pontine fibres which have stereopractic functions; the increase of the parieto-occipital is associated with the stereognostic projections of the pulvinar, and is thus correlated with the recognition of external objects by means of the skin, joint, and muscle sensibility. Dr. Kappers wisely refrains from giving any anatomical explanation of the increase of the temporo-occipital region of the cortex, but hints that owing to the connexion of the occipito-temporal lobe with the red nucleus it may, in addition to its acoustio-visual correlations, be some sort of stereognostic centre.

Dr. Kappers has brought his extensive knowledge and consummate skill as a draughtsman to bear on the preparation of the plates. The results are at first sight somewhat bewildering in their complexity, but they will prove invaluable to the student and investigator of comparative neurology.

Air Ministry: Meteorological Office. British Meteorological and Magnetic Year Book, 1918. Part 5: Réseau Mondial, 1918. Monthly and Annual Summaries of Pressure, Temperature, and Precipitation at Land Stations, generally Two for each Ten-degree Square of Latitude and Longitude. (M.O. No. 2318.) Pp. xiii+116. (London: H.M. Stationery Office, 1925.) 21s. net.

THE present volume is the ninth of the series, the work now being completed for each year from 1910 to 1918. All the information refers to land stations; it has not yet been practicable to give data over the sea. The total number of stations utilised is 449, which is 9 fewer than in 1917. Stations are easily identified by a systematic numbering, maintained year after year. The majority of the stations for which information is given are under the control of government meteorological services. Wherever possible, the departures from normal of the monthly and annual values of mean pressure, mean temperature, and precipitation are given. Wind data are given for selected stations in the tropics; and there are notes on the state of the ice in the Arctic Seas and in the North Atlantic Ocean.

When data are received for another year, making a consecutive period of ten years, there will be sufficient information for many tentative inquiries, such as stable or varying barometric pressure from year to year over the whole globe, the effect and influence of normal and abnormal changes in one part of the globe on the conditions experienced elsewhere, the controlling factors being of much value for long period forecasting.

The highest mean shade temperature for 1918 was 86° F. at Berbera, Somaliland: the lowest mean 4° F. at Verkhoiansk. The absolutely highest temperature was 115° F. at Bourke, in New South Wales, on December 9: the second highest was 114° F. at Berbera on July 12, 16, and 25: the absolutely lowest was -76° F. at Verkhoiansk on February 2. The heaviest total rainfall for the year was 511 inches at Cherrapunji, which is 87 inches more than the average; 170 inches fell in June. The latter is more than seven times as heavy as the annual average fall at Greenwich. No rain fell during the year at Insalah or Iquique.

Tabulae Biologicae. Herausgegeben von C. Oppenheimer und L. Pincussen. Band 1: Reine und physiologische Physik, physikalische Chemie und biologische Anwendungen. Pp. vi+522. (Berlin: W. Junk, 1925.) Subscriptionspreis für alle vier Bände (einzelne Bände werden nicht abgegeben) 100 marks.

THESE are, we believe, the first biological tables of their kind, and in one respect they indicate very clearly the degree to which the biological sciences have advanced quantitatively. The old barriers dividing the so-called exact and the descriptive sciences are down, and many are exploring long-neglected territory. Science has to wait for its problems to be tackled, but there are now biologists who can themselves go a long way in problems

demanding some exact science. To these and to others following in their wake, we think that these tables will be of great service.

The authors are very frank in acknowledging the prototype of their work, and they assure us that what they have prepared is nothing but a Landolt-Börnstein of the entire field of biology; this includes physiology, anatomy, medicine, hygiene, zoology, botany, technics, pharmacology and bacteriology.

The range of information is extraordinarily wide, but there remains the all-important question of accessibility of the data. How easy is it to find the required information? The volume under review contains 522 pages, literally packed with data. The table of contents occupies one page and indicates thirty-four different sections. While, of course, some sections are longer than others, it will be seen that considerable time must be taken in getting what these tables have to give; vastly less time, however, than by any other method. Readers have the opportunity of consulting the original papers, for references to these are given at the ends of the sections. The authors have been at great pains to secure trustworthy data, and we have little doubt that advantage will be taken by scientific workers and readers of this mass of information.

Plant Life on East Anglian Heaths: being Observational and Experimental Studies of the Vegetation of Breckland.

By Dr. E. Pickworth Farrow. Pp. x+108+23 plates. (Cambridge: At the University Press, 1925.) 7s. 6d. net.

THE interesting studies of vegetation at Breckland, East Anglia, which Dr. E. Pickworth Farrow has been publishing in the *Journal of Ecology*, have now been gathered together and published, with additional matter, in book form. This work provides the most definite and striking data as to the effects produced by rabbits in determining the nature of the vegetation. Thus their influence is traced in the degeneration of Calluna heath to grassland and in the prevention of natural regeneration of woodland. Interesting notes are provided on wind effects upon Calluna in sandy soils and upon the water supply in the soil as a determining factor in the type of vegetation of the soils at higher levels at Breckland, but in the main this work is characterised by the manner in which it underlines the significance of biotic factors. Cases that may be cited, in addition to the rabbits, are the effect of the shade thrown by Pteris, notably by the dead fronds, upon the spread of Calluna, and the influence of the litter of needles below the pines upon the spread of *Carex arenaria*.

Analytical Geometry of Conic Sections and Elementary Solid Figures. By Dr. A. Barrie Grieve. Pp. xv+314+xiv. (London: G. Bell and Sons, Ltd., 1925.) 9s. net.

A TEXT-BOOK for students who have already finished the straight line and circle: its contents are about equally divided between the conic sections and the geometry of three dimensions, finishing with confocal quadrics and a chapter on curvature. The author wisely uses the calculus for finding gradients, but also gives the alternative treatment. The book can be confidently recommended for boys reading for scholarships and for first-year students at universities.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Boskop Skull.

TWELVE years ago there was discovered in the Transvaal a remarkable human skull of apparently great antiquity. Fitzsimons, of Port Elizabeth Museum, first described it as perhaps allied to the Neanderthal but without the large supra-orbital ridges. The skull was next sent to Capetown on loan, where it was described at some length by Haughton as allied to the Cromagnon man. Shortly afterwards I examined it in Port Elizabeth, and, impressed by the huge size of the brain, the great thickness of the bone—in places 15 mm.—and certain remarkable features in the jaw, I thought it worthy of specific rank and named it *Homo capensis*. Now the specimen has been sent to the British Museum for further examination, and there has just appeared a paper by Pycraft which will be regarded as the official British Museum report.

Prejudice has played a considerable part in anthropology. Since the belief in evolution became accepted, all old human skulls are expected to be ape-like, and if not ape-like are regarded with suspicion. Doubts have been thrown on the Galley Hill skull because it is not sufficiently anthropoid. When in 1855 a human jaw was found in the Red Crag it was submitted to Owen, Huxley, Lyell, and all the leaders of the day, but as it was not like an ape's jaw they all shook their heads and said it was an interesting curiosity, and as no one recognised its value the jaw got lost. The Boskop skull has been threatened with a similar fate. It has an enormous brain and is not at all ape-like. Therefore, according to some, it cannot be old, and in any case cannot be very interesting.

Pycraft, in concluding that it is a Proto-Bushman type, agrees with the view I expressed some years ago, and in his phylogenetic tree he places it low down on the branch that leads to the Bushman and Negro. Unfortunately elsewhere in the paper he states "very certainly that he was a derivative of Cromagnon man," and Cromagnon man he places well up the branch that gives rise to the European types of to-day.

By means of certain formulæ Pycraft estimates the cranial capacity at 1717 c.c. Haughton estimated it at 1832 c.c., Elliot Smith puts it at 1900, and I made it 1950 c.c. Sollas has just shown that those beautiful formulæ, while fairly trustworthy for normal-sized skulls, are quite untrustworthy for large skulls, giving at times an error of more than 200 c.c. If instead of estimating the capacity by formulæ suitable for normal skulls of *Homo sapiens*, which do not take into consideration the abnormal thickness in places; and the unusual thinness in others of a skull like the Boskop, we make a cast of the brain in plaster and restore it into at least approximately its original condition and then measure its size, as I have done, I still feel quite confident the capacity will be found to be more than 1900 c.c.

In Pycraft's paper there is one serious omission which I deeply regret. He admits that there is preserved "a fragment of a mandible" and it is not at all an inconsiderable fragment. It was on this jaw largely that I (not Hewitt, as Pycraft states) founded the species *Homo capensis*, believing that the jaw differs in certain characters from all other known human types. I may be entirely wrong in my view

of the jaw, but it was with considerable disappointment that I found Pycraft had a good deal to say on the easy problem of the cranium, and not a single word to say on the more interesting and much more difficult problem of the jaw, and until this mandible has been fully investigated by some expert we cannot accept as final any verdict pronounced on the cranium alone.

Douglas, South Africa,
November 10.

R. BROOM.

The Energy liberated by Radium.

WHEN radium is in equilibrium with its disintegration products, it is known that the number of atoms of each of the products disintegrating per second is the same, and that this is equal to the number of α - or β -particles emitted by each product per second, according as the transformation is accompanied by α - or β -ray emission respectively. Moreover, in the case of those products (RaB and RaC) which emit γ -rays, Kovarik (*Phys. Rev.*, 23, 559, 1924) has recently established the important result that each disintegrating atom emits only one γ -ray (quantum). The number of γ -quanta emitted per second by the amount of Ra(B+C) in equilibrium with 1 gm. of radium was found to be 7.28×10^{10} , from which we may conclude that each product emits 3.64×10^{10} γ -quanta per second.

Much valuable information on the energy of the γ -rays emitted by radioactive substances has also been obtained by measuring the energy of the β -rays excited by γ -rays incident on various elements, and afterwards applying Einstein's photoelectric equation, but further work will be necessary before our knowledge of the energy of the γ -rays is complete. Recent experimental work by Ellis (*Phil. Mag.*, 50, 521, 1925) has shown that the contribution of the γ -rays from Ra(B+C) to the total heat production of radium together with its short-lived products amounts to about 6.3 per cent, a value which is about 1.6 per cent higher than that hitherto accepted. Theoretical calculations of this heat production have also been carried out, on the basis of the photoelectric data on the energy of the γ -rays, referred to above. Thus Meitner (*Die Naturwissenschaften*, 12, 1146, 1924) finds that the γ -rays from Ra(B+C) contribute slightly less than 9 per cent of the total heating effect of radium (ca. 137 cal./hour/1 gm. Ra), whereas Thibaud (*C.R.*, 180, 1166, 1925) calculates that they contribute slightly more than 5 per cent of the total heat production. The deviations of these calculated values from that found experimentally by Ellis are probably due to the fact that the γ -radiation from these elements is not homogeneous, but consists of several wave-lengths, which means that we must know how much these individual frequencies contribute to the aggregate effect, and on this point there is not complete unanimity of opinion. Moreover, such calculations involve a knowledge of the number Z of atoms of radium disintegrating per second per 1 gm. of the element, and here again there is a divergence of opinion. Meitner uses the value 3.5×10^{10} ; Thibaud uses the value 3.57×10^{10} (Rutherford-Geiger); whilst Ellis (*l.c.*) recently used the value 3.4×10^{10} (Geiger-Werner, *Zeit. f. Phys.*, 21, 197, 1924).

Interesting information on the latter point can be obtained if we attempt to calculate the total heating effect due to 1 gm. of radium alone, i.e. free from its disintegration products. Here the conditions are simplified, for radium does not emit primary β -particles. Moreover, the γ -radiation emitted by radium is homogeneous (cf. Meitner, *l.c.*)— $\lambda = 6.64 \times 10^{-10}$ cm.—and its energy can be calculated if we make what

seems to be a plausible assumption, namely, that the number of γ -quanta emitted per second by 1 gm. Ra has the value Z . The total heat production is obtained by adding this amount to that due to the α - and recoil particles. The results of this calculation are given below, (1) on the basis of Geiger's value of $Z = 3.40 \times 10^{10}$, and (2) on the basis of the value of Hess-Lawson (*Wien. Ber.*, 127, 405, 1918; *Phil. Mag.*, 48, 200, 1924), namely, $Z = 3.72 \times 10^{10} \pm 0.02$.

The energy (E_a) of each α -particle emitted by radium has the value 7.529×10^{-6} erg, that of the recoil particle ($E_r = \frac{m_a}{M_r} E_a = 0.018 E_a$) amounts to 0.136×10^{-6} erg, and each γ -quantum possesses an amount of energy of magnitude 0.296×10^{-6} erg. Thus the total energy liberated per atom disintegrating amounts to 7.961×10^{-6} erg. From this it is a simple matter to calculate the total heat development H of 1 gm. of radium in calories per hour. We obtain the following results:

- (1) for $Z = 3.40 \times 10^{10}$, $H = 23.28$ cal./hour.
 (2) for $Z = 3.72 \times 10^{10}$, $H = 25.47$ cal./hour.

Value of H obtained experimentally = 25.2 cal./hour.

We see, then, that the deviation of the calculated from the experimental value of the heat production of radium amounts to about -8 per cent or +1 per cent, according as we make use of $Z = 3.40 \times 10^{10}$ or 3.72×10^{10} respectively.

Now a consideration of the value 25.2 cal./hour for the heat development of 1 gm. of radium, as obtained by Hess (*Wien. Ber.*, 121, 1419, 1912), indicates that it is more likely to be a shade below than above the true value. The determination was made with nearly $\frac{1}{2}$ gm. of radium, which had been specially purified by Hönigschmid for atomic-weight determinations, and great care was taken to eliminate the effect of the decay products of radium from the result. On the other hand, the possible contribution of the γ -rays from radium to the heating effect was at that time generally regarded as negligible. Recent work, however, shows that it is not so. Absorption measurements with the γ -rays from radium yield three values of μ (in aluminium) for these rays, namely, 354, 163, and 0.27 cm^{-1} . The half-value thicknesses corresponding to these absorption coefficients are 0.002, 0.042, and 2.56 cm of aluminium respectively. Now the thickness of absorbing material in Hess's determination of the heat production of radium was equivalent to 4.9 cm. of material of unit density, which corresponds to 1.8 cm. of aluminium.

It follows that the first two constituents of the γ -radiation referred to above would be completely absorbed, whereas less than half of the third and nuclear constituent would suffer absorption. An exact estimate of the fraction of the total γ -radiation which remained unabsorbed in the experimental determination is not readily obtainable, but it would almost certainly be less than half the total. In other words, since the total heat developed by the γ -radiation from 1 gm. of radium works out to be 0.947 cal./hour, the corrected hourly heat development due to all the rays emitted by 1 gm. Ra, as determined experimentally by Hess, cannot differ much from 25.5 cal., a value which is almost identical with that calculated under (2) above.

A comparison of the above results of theory and experiment thus lend strong support to the essential correctness of the value $Z = 3.72 \times 10^{10}$ for the number of α -particles emitted by 1 gm. of radium per second, and it is significant that Kovarik's work on γ -rays is in substantial agreement with this result.

In the above calculations, I have endeavoured to use the most accurate data available for the various

quantities involved, and it is important that the values used should be stated. They are as follows: (1) Wave-length of γ -rays from radium = 6.64×10^{-10} cm. (Hahn-Meitner); (2) velocity of α -particles from radium = 1.511×10^9 cm./sec. (Geiger); (3) mass of α -particle = 6.595×10^{-24} gm; (4) velocity of light = 3.000×10^{10} cm./sec.; (5) Planck's constant (h) = 6.55×10^{-27} erg sec.; (6) Joule's equivalent = 4.186×10^7 ergs/calorie.

ROBERT W. LAWSON.

University of Sheffield,
November 9

Human Personality and Biochemistry.

A REVIEW of Prof. Louis T. More's "The Dogma of Evolution" (*NATURE*, October 17, 1925, p. 562) contains this sentence.

"The absurdity of some of the attempts to overcome this difficulty quoted by Prof. More, is almost incredible, as, for example, that of Prof. Ritter who maintains that every individual organism is a chemical compound!"

Here are the words in More's quotation from me to which this statement probably refers.

"An essential implication of this proposition is that every living individual organism has the value, chemically speaking, of an elementary chemical substance."

It seems from this that to the reviewer (signed E. W. M.) the words "has the value of an elementary chemical substance" mean the same as the words "is a chemical compound." To me the two phrases are very far from meaning the same thing. But were there no better reason than a desire to debate this point of difference between the reviewer and myself, I should not feel justified in asking *NATURE* for space in which to print even a brief communication in connexion with the criticism passed upon others and me by More and E. W. M. But I think there is a much better reason for requesting such a privilege.

According to this reviewer, the "incredible absurdity" committed by me resulted from the "difficulty of explaining how the typical proportions of this mixture [of compounds]" (*i.e.* of which protoplasm is now known to be composed) is maintained. Where he got the impression that I was trying to "explain" the phenomenon he mentions it is hard to see. For neither the word explain nor any synonym for it occurs in More's quotation from me, or anywhere in the original discussion.

As a matter of fact, my object in formulating the hypothesis quoted by More was very different from what E. W. M. says it was. This I think he could scarcely have failed to recognise had he read somewhat carefully all I wrote on the subject. But since More and E. W. M., and so presumably others who may have read my discussion, have missed by a long way what I was trying to bring out, I wish now to see if I cannot state the point in a nut-shell and so clearly as to ensure against it being misunderstood by anybody else who may chance to be interested in my results on the general subject dealt with.

What I tried to do originally was to bring into recognisably harmonious relation with each other two groups of facts concerning organisms, human organisms especially, which are questioned by nobody of good sense and sound learning, although scarcely anybody is able to see exactly how they can get on together in one and the same individual.

One of these factual groups is human personality; the other is the human organism's ability to continue to live by means of its food substances. How, for example, is it possible for a great Nordic statesman

and his humble negro valet to breathe the same kind of air, drink the same kind of water, and eat the same kinds of solid food year in and year out, and yet one of them go right on being a great Nordic while the other as persistently continue to be a humble negro? If there is any truth in Feuerbach's epigram, "Mann ist, was er isst," how can such a thing be?

What I wrote, essentially, in attempting to throw some light into this dark place, which has drawn the fire of these critics is this. Every elementary substance is different from every other as to its physical attributes and as to the products of its chemical reactions with other elementary substances. Likewise every human person is different to some extent from every other as to many of his physical attributes, and as to his chemical reactions with certain elementary substances, notably with atmospheric oxygen. That these two groups of facts constitute a rather striking resemblance between a chemically elementary substance and a human organism scarcely needs saying in so many words when they are presented in this bald way.

I further directed attention to the idea that the validity and perhaps the significance of this resemblance are increased by drawing consciousness into the comparison. Thus when the conscious organism is deprived of air (oxygen) its consciousness ceases as inevitably and almost as promptly as does the flame of a lump of phosphorus or sulphur under like deprivation. Furthermore, the utter differentiatedness of every person's conscious activity from every other person's, and the consequent possession by every person of a measure of genuine uniqueness, is comparable with the differentiation that characterises the chemical reaction of every elementary substance with every other such substance.

As to its conscious life especially, the definitiveness of every human person is like unto the definitiveness of a chemically elementary substance.

To show that the separate reality of each and every conscious person is comparable with the separate reality of each and every chemically elementary body is the essence of my discussion from which More quotes. What I did was to manipulate, by the methods of description and comparison, certain well-established facts concerning the nature of man and some other organisms, and other well-established facts concerning the nature of certain inanimate bodies, with the view of finding how much they have in common.

If this performance deserves to be stigmatised as "incredibly absurd" materialism, the stigma rests on the facts rather than on me.

The separate and more difficult question of whether such a way of treating the facts really connotes materialism cannot, of course, be gone into in a brief communication like this.

This much may, however, be said. My description of conscious human personality recognises its utter dependence on material substances and atoms, but it also recognises that the worth and dignity of each human person are real in the same sense that the atoms themselves are real. So far as I can learn, materialism has never recognised such a relation between a personality and the atoms of which it is composed.

WM. E. RITTER

Science Service,
Washington, D C,
November 11

PROF. RITTER's further explanation of his meaning leaves me gasping! Apparently I did him an injustice in supposing that he meant to compare the human organism to a chemical compound. What he really intended was to compare each human individual

to a chemical element. Just as each element reacts differently with oxygen and thereby manifests its individuality, so each human being reacts differently to oxygen, and in this his personal peculiarities find their explanation.

We might remark that chemical atoms (barring radioactive transformations) persist and are indestructible, whereas the human being in so far as he consists of matter is a temporary phenomenon. Further comment, however, on this extraordinary comparison appears to be superfluous.

E. W. M.

A Surface Catalysis in Photochemical Processes.

DURING the course of an investigation on the photochemical combination of gases, our attention was directed to the marked diversity in the rate of combination of gases such as hydrogen with oxygen, ethylene and carbon monoxide, effected by irradiation in quartz tubes with the mercury vapour lamp, observed by different investigators.

It is a well-established fact that pure hydrogen and oxygen can combine when subjected to radiation of short wave-length, but owing in general both to the weak absorption coefficient of the gases, probably oxygen being the important constituent, and the feeble nature of light at wave-length shorter than the resonance line $\lambda = 2537 \text{ \AA}$ to which such photo-activity is due, the rate of combination is generally small. Indeed at low pressure Dickinson failed to note any combination. Again, if mercury vapour be admitted to the system, Franck and Caro have pointed out that the mercury atoms are activated to the $2p_2$ state by absorption of quanta of light of wave-length $2537 \text{ \AA}$ U., and such activated mercury atoms on collision with hydrogen molecules produce an active modification of hydrogen which can react either with the gases mentioned above or with metallic oxides. It is uncertain at the present time whether this "active" modification so produced consists of activated hydrogen molecules, a point of view held by Mitchell, hydrogen atoms as suggested by Franck and Caro, or an unstable but active mercury hydride postulated by Compton.

When a comparison is made of the rates of these two homogeneous gas reactions obtained by observers such as Franck and Caro, Dickinson and Mitchell, with the relatively high rates obtained by Berthelot and Gaudechon, Baker, and especially Taylor, on illuminating a gas mixture *in the presence of liquid mercury*, it was evident that the discrepancy was too great to be accounted for by variations in the intensity of the line $\lambda = 2537 \text{ \AA}$ U. from the lamps of the different observers. Taylor indeed has recently realised this discrepancy and suggested that combination is in effect a chain mechanism of the type postulated by Christiansen and Kramers. Whilst some species of chain reaction does undoubtedly occur in a few cases, such as in the combination of hydrogen and chlorine, it appears improbable that the diversity of the results between the two groups of experimentalists can be attributed to some unknown factor causing the inhibition in the former, or the propagation of chains in the latter cases.

An investigation of the catalytic effect of a mercury surface in the photochemical combination of these various gas mixtures revealed the interesting fact that combination between these gases is promoted by a mercury surface when illuminated at ordinary temperatures with radiation from a quartz mercury vapour lamp under the conditions of strong emission of the resonance line $\lambda = 2537 \text{ \AA}$ U.

We have likewise made a search for any catalytic effect of metals such as iron, copper, cadmium, and silver, when radiated with the mercury and cadmium

vapour lamp and the iron arc, but apart from the already well-known small increase in the rate of oxidation of reduced iron and copper on illumination, no definite signs of catalytic effects were obtained, possibly on account of the relatively feeble intensity of the resonance lines for these metals in the arcs employed. In the case of mercury irradiated with the water-cooled mercury arc the catalytic effect is, however, most distinct. Thus in a series of experiments with ca. 30 c.c. of hydrogen and oxygen, in an approximate ratio of 2:1, at a total pressure of 300 mm., both in the absence and presence of mercury vapour the rate of combination was so slow that in a period of five hours a change in pressure of less than 1.0 mm. was obtained. In the presence, however, of a layer of mercury 10 cm. long, disposed in the horizontal reaction tube, a change in pressure of 60 mm. an hour was obtained. The rate of change is to a first order proportional to the area of mercury exposed. Amalgamated silver is likewise effective as a catalyst, but amalgamated brass possesses but little efficiency. In this latter case it may be observed that owing to the operation of the forces of surface tension, zinc and not mercury is the predominant constituent of the surface layer.

Whilst in the absence of hydrogen, ozone can be identified by the tailing of the mercury, when hydrogen is present mercuric oxide is formed on the mercury surface and is also deposited on the tube walls.

Auto-retardation of the rate of reaction is to be noted when formaldehyde and its polymerised products from carbon monoxide and hydrogen condense on the previously clean mercury surface. Although ethylene is sensitive to light in the absence of mercury, the combination of this gas with hydrogen proceeds smoothly at a greatly accelerated rate in the presence of the illuminated mercury surface.

The operation of this hitherto unsuspected catalytic action of a mercury surface in the photochemical combination of gases provides a reasonable explanation, so far as can be ascertained from the published information on the experimental methods adopted, for the high rates of combination frequently observed. It must, however, be admitted that the data of Coehn and Tramm do not conform to this view, for a remarkably rapid rate of combination was obtained for pure gases. It is possible that mercury was actually present, being drawn into the reaction vessel from the one ground-in joint with which their reaction system was provided, since their diagram lends support to the view that the joint was provided with a mercury seal.

We have not as yet obtained definite information as to the quantum efficiency of the surface, or whether water vapour is essential for this surface action; it appears, however, to be unnecessary for the operation of the Franck and Caro mechanism.

H. S. HIRST
E. K. RIDEAL.

Laboratory of Physical Chemistry,
Cambridge,
November 20.

The Cierva Auto-gyro.

IN his article on the Cierva auto-gyro in NATURE of October 31, Prof. Bairstow repeats an argument originally used against the helicopter, that the longer spiral path of the blades, as compared with the straight path of aeroplane wings, causes a greater expenditure of energy for a voyage of a given length from point to point.

Munk arrives at the contrary conclusion in Technical Note No. 221 of the American Advisory Committee for Aeronautics. On pp 10-11 he writes:

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"The average velocity of the helicopter blade is greater than that of the aeroplane wing and this involves greater loss. . . . However, the helicopter makes up again for this by its smaller wing area . . ." and finally, "The loss due to the drag of the [helicopter] wing is accordingly smaller."

I find it difficult to simplify the basis of comparison sufficiently to draw any general conclusion, but am of the opinion that Prof. Bairstow's argument requires considerable modification on the lines laid down by Munk.

A. R. LOW.

London, November 28, 1925

THE argument for relative efficiency of aeroplane v. auto-gyro as given in my article does not depend on the area of the wings used, and it would seem that Munk can only reach his conclusion by imposing on the aeroplane some disability not shared by the auto-gyro. The disability is made clear on p. 11 of the report referred to by Major Low, where we find "the aeroplane wing area is not chosen for the ordinary velocity of flight, but for the much smaller velocity used for taking off and landing, and in consequence is much greater than it would need be for ordinary flight alone". This paragraph means that at high speeds an aeroplane cannot use its wings at the best ratio of lift to drag, and this is a well-known phenomenon. The argument as to the advantages and disadvantages of the two types of craft becomes very technical if carried into this stage, and I cannot press my point further here than as one of opinion backed by the knowledge that experiments have not yet demonstrated the capabilities of the auto-gyro to overcome the disadvantage of the aeroplane to which attention has been drawn by Munk.

Put in terms of lift/drag the difference of statement seems to disappear; on p. 7 of N.A.C.A. Tech. Note No. 221 Munk says: "I proceed now to the energy balance of the tilted propeller. This will give information on the economy of the helicopter. It is enough to analyse the results of tests 136 to 141, which is done in Table VIII. The table shows that the ratio L/D of the propeller is considerably smaller than for ordinary wings . . ." L. BAIRSTOW

The Free Path of Slow Protons in Helium.

POSITIVELY charged hydrogen atoms with velocities acquired by falling through 300 to 900 volts have been found to possess an unexpected range in helium and other gases. With helium pressures so high as 0.5 mm. of mercury, the protons will complete a semicircular path 16 cm. in length and still appear as a positively charged bundle of rays. The magnetic deflexion shows also that they remain charged throughout their entire path. As the free path given by the kinetic theory of gases for a rapidly moving particle is 1.5 millimetres at this pressure, the protons must pass unaltered through more than one hundred helium atoms. The capture of electrons by α -rays of various velocities observed by Henderson and Rutherford, and R  chardt's experiments with canal rays, would lead one to expect a rapid neutralisation of protons of this velocity. The neutralisation of the more rapidly moving particles observed in those experiments has been explained by the presence of a great number of electrons, due to ionisation, with which the particles may combine, and we may account for the absence of neutralisation in the present experiments by the assumption that no free electrons are produced by protons of the velocity used. In fact, energy considerations would suggest the improbability of an

electron leaving a helium atom with an ionisation potential of 24.5 volts, in order to form a neutral hydrogen atom possessing a much smaller ionisation potential.

Singly charged helium atoms apparently do become neutralised, since they rapidly disappear as the pressure is increased. At 0.01 mm. pressure they are much weakened, and are entirely absent at a pressure of 0.027 mm. of mercury. Charged hydrogen molecules disappear at a higher pressure (0.07 mm.) than the charged helium atoms. They are probably dissociated without alteration of velocity or direction, at collisions with the helium atoms, since their disappearance, as the pressure is increased, is accompanied by the appearance of a group of protons with the slow velocity of the original molecules.

A. J. DEMPSTER.

University of Chicago,
November 9.

Winter Thunderstorms, 1925.

A LARGE number of reports were received in response to an appeal for observations of thunderstorms occurring in the British Isles during the first three months of this year. The following table shows the number of days on which thunder or lightning was reported:

1925.	England and Wales.	Scotland.	Ireland.	British Isles.
January . . .	10	12	10	17
February . . .	20	10	8	23
March . . .	16	5	4	17
Total (3 months)	46	27	22	57

The stormiest areas in England were mainly on or near the south coast, and in Scotland they were in the central part of the west coast. Large areas in the northern and midland counties of England, and a large part of Wales, were free from storms.

The investigation will be continued during the first three months of 1926, and in thanking those who sent information last winter, may I ask for similar reports next year?

S. MORRIS BOWER.

Langley Terrace,
Oakes, Huddersfield,
December 1.

A Further Case of Sub-Harmonics.

THAT notes may be produced by the intermittent contact of a tuning-fork and another body, the frequencies being sub-multiples of that of the fork, has been shown in my earlier communications (NATURE, March 8, 1924; *Phil. Mag.*, January 1925). This letter is to point out that such sub-harmonic notes can also be obtained by rubbing with a wetted finger on or near the rim of an ordinary thin tumbler or of a wine-glass. The note most easily obtained corresponds to the fundamental "bell" mode of vibration in four segments, as may be seen by the ripples produced on a little water placed in the glass (one of the four nodal lines ends at or near the moving finger). By pressing harder and moving the finger more slowly, notes of a half, a third, and a quarter of the frequency of the above note can similarly be obtained. All these notes fall in pitch simultaneously when more water is placed in the glass. (Another note may occur, apparently due to the simple torsional vibration of the glass. This note is unaltered in pitch by varying the amount of water.)

W. N. BOND.

University College, Reading,
November 9.

The London Skull.

As Prof. Elliot Smith states in his letter to NATURE of December 5, a sample of the blue clay in which the skull was found at Lloyd's has been forwarded to me for examination at the instigation of Mr. Warren B. Dawson.

I am anxious to remove at once any possible misunderstanding regarding the results of my examination. It may have been thought that as I was familiar with the brick-earths in East Anglia, in which Mr. Reid Moir has found so much evidence of Moustertian culture, I might be able to establish some kind of correlation. As I pointed out at once, however, to Mr. Dawson, this was unlikely. The blue clay happens to be lithologically different from the Moustertian brick-earths of Suffolk, but even if it were similar petrographically, I should still regard its indigenous fauna as the only safe basis for correlation and determination of age.

My examination of the inorganic constituents of the clay may throw light on the conditions of deposition and the source of the material. I must leave the question of its age in the competent hands of Messrs. Bromehead and Hinton, who I hope will find it possible to arrive at an agreement.

P. G. H. BOSWELL.

Department of Geology,
University of Liverpool,
December 7.

Early Use of Lightning Conductor.

MR. H. C. BROWNE, in a letter on the early use of the lightning conductor (NATURE, Aug. 15, p. 242), quotes the "Tableau de Paris." Readers of NATURE may wish to refer to this interesting work. The "Tableau de Paris" was published between 1781 and 1788 in twelve volumes, by L. S. Mercier. The chapter quoted by Mr. Browne is of 1783. In the last volume of the collection is another chapter on the same subject, in which Mercier recants his former belief in the lightning conductor; he says: "In a city of 800,000 souls, I have not seen, in forty years, a single person killed by lightning."

Mercier's incredulity in scientific matters culminated, many years later, in a work the title of which speaks for itself: "De l'impossibilité du système astronomique de Copernic et de Newton" (Paris, 1806).

T. V. BENN.

Clermont-Ferrand,
October 31.

A Gift of Fleuss Vacuum Pumps.

WE have for disposal a few Fleuss vacuum pumps suitable for laboratory experimental work. The pumps can be either hand-worked or power-driven by a belt on the fly-wheel. They occupy a floor space of about 24 in. x 14 in. So far as the number available permits, we should be pleased to give one to any university laboratory or educational establishment in Great Britain where such a pump would be of value for experimental work.

The object of this letter is to make the fact known in the hope that any one desiring one of these pumps may see this letter and communicate with us direct.

C. C. PATERSON.

Research Laboratories of the General
Electric Company, Ltd.,
Wembley, December 8.

Atoms and X-Rays.¹

By Dr. F. W. ASTON, F.R.S.

ISOTOPES AND IONISATION.

THE idea that all atoms of matter might be built of the same primordial units, that is to say, might differ not in material but only in construction, dates back at least as far as Prout. This philosopher endeavoured more than a century ago to show that atoms of all elements were themselves built of atoms of hydrogen. A little earlier Dalton had postulated, in probably the most important theory in the whole history of chemistry, that atoms of the same element were of equal weight. If both these theories were right, the atomic weights of all elements would be comparable with each other as whole numbers. This the chemists soon found was quite incompatible with experimental evidence. They had to choose between the two theories and chose the one that was untrue. In this they were perfectly right, for it is more important that a scientific theory should be simple than that it should be true.

The point cannot be tested by chemical methods, for these require a vast number of atoms, and so can only yield a mean result. The way in which Dalton's postulate was first attacked and shown to be incorrect was in the province of radioactivity, when Soddy showed that lead which was produced from thorium minerals had a different atomic weight from the lead which was produced from uranium minerals. This meant that substances could exist which had identical chemical properties but different atomic weights; these Soddy called isotopes. This reasoning could not be applied to ordinary elements. For these there is only one conclusive test, which is to compare the weights of individual atoms. It is here that positive rays are of such value, for they are atoms carrying a positive charge and moving with so high a speed that they can be detected by a fluorescent screen or photographic plate.

The first experimental comparison of the weights of individual atoms was made by Sir J. J. Thomson by his "parabola" method, in which the rays are subjected to electric and magnetic fields giving deflexions at right angles to each other. Subjected to this test, many of the elements seemed to obey Dalton's rule, giving single or apparently single parabolic streaks expected from groups of atoms travelling with different velocities but all of the same mass. But results obtained with neon suggested that in this gas the atoms were of two different weights 20 and 22, the accepted atomic weight being 20.20. The accuracy of the parabola method of analysis was not sufficient to prove the point, but this was done by means of the mass-spectrograph. With this instrument, by using electric and magnetic fields giving deflexions at 180° to each other, it is possible to focus the rays and obtain a spectrum dependent on mass alone. By measurements of this mass-spectrum it is possible to compare the weights of atoms to one part in 1000. In this way a satisfactory proof was obtained that neon did consist of two isotopes 20 and 22, which, present in the proportion 9 to 1, give the mean atomic weight 20.2. Chlorine, the chemical atomic weight of

which is 35.46, was found to consist of two isotopes, 35 and 37. Many of the elements, such as carbon, oxygen, nitrogen, etc., were found to be "simple," that is, to consist of atoms all of the same weight, but even more were found to be "complex," mixtures of two or more isotopes. Selenium, krypton, cadmium and mercury each have six, tin probably eight, and xenon possibly nine isotopic constituents. In all, fifty-six out of the eighty known non-radioactive elements have been analysed into their constituent isotopes or shown to be simple with the results given in the table.

TABLE OF ELEMENTS AND ISOTOPES.

Elements.	Atomic Number	Atomic Weight.	Minimum Number of Isotopes.	Mass-numbers of Isotopes in Order of Intensity.
H . .	1	1.008	1	1
He . .	2	4.00	1	4
Li . .	3	6.94	2	7, 6
Be . .	4	9.02	1	9
B . .	5	10.82	2	11, 10
C . .	6	12.00	1	12
N . .	7	14.01	1	14
O . .	8	16.00	1	16
F . .	9	19.00	1	19
Ne . .	10	20.20	2	20, 22
Na . .	11	23.00	1	23
Mg . .	12	24.32	3	24, 25, 26
Al . .	13	26.96	1	27
Si . .	14	28.06	3	28, 29, 30
P . .	15	31.02	1	31
S . .	16	32.06	1	32
Cl . .	17	35.46	2	35, 37
A . .	18	39.88	2	40, 36
K . .	19	39.10	2	39, 41
Ca . .	20	40.07	2	40, 44
Sc . .	21	45.1	1	45
Ti . .	22	48.1	1	48
V . .	23	51.0	1	51
Cr . .	24	52.0	1	52
Mn . .	25	54.93	1	55
Fe . .	26	55.84	2	56, 54
Co . .	27	58.97	1	59
Ni . .	28	58.68	2	58, 60
Cu . .	29	63.57	2	63, 65
Zn . .	30	65.38	4	64, 66, 68, 70
Ga . .	31	69.72	2	69, 71
Ge . .	32	72.38	3	74, 72, 70
As . .	33	74.96	1	75
Se . .	34	79.2	6	80, 78, 76, 82, 77, 74
Br . .	35	79.92	2	79, 81
Kr . .	36	82.92	6	84, 86, 82, 83, 80, 78
Rb . .	37	85.44	2	85, 87
Sr . .	38	87.63	2	88, 86
Y . .	39	88.9	1	89
Zr . .	40	(91)	3 (4)	90, 94, 92, (96)
Ag . .	47	107.88	2	107, 109
Cd . .	48	112.41	6	114, 112, 110, 113, 111, 116
In . .	49	114.8	1	115
Sn . .	50	118.70	7 (8)	120, 118, 116, 124, 119, 117, 122, (121)
Sb . .	51	121.77	2	121, 123
Te . .	52	127.5	3	128, 130, 126
I . .	53	126.92	1	127
X . .	54	130.2	7 (9)	129, 132, 131, 134, 136, 128, 130, (126), (124)
Cs . .	55	132.81	1	133
Ba . .	56	137.37	(1)	138
La . .	57	138.91	1	139
Ce . .	58	140.25	2	140, 142
Pr . .	59	140.92	1	141
Nd . .	60	144.27	3 (4)	142, 144, 146, (145)
Hg . .	80	200.6	6	202, 200, 199, 198, 201, 204
Bi . .	83	209.00	1	209

By far the most important result of these measurements is that with the exception of hydrogen, the weights of the atoms of all the elements measured, and therefore almost certainly of all elements, are whole numbers to the accuracy of experiment, namely, about one part in a thousand. Of course, the error expressed in fractions of a unit increases with the weight measured,

¹ From the presidential address delivered before the Röntgen Society on November 3.

but with the light elements the divergence from whole numbers is extremely small. This generalisation, which is called the *whole number rule*, has removed the only serious obstacle to the electrical theory of matter. It enables us to restate Prout's original hypothesis with the modification that the primordial atoms are of two kinds—protons and electrons, the atoms of positive and negative electricity. The proton is very much smaller and heavier than the electron, actually about 1850 times as heavy. According to the nucleus atom theory which we owe to Sir Ernest Rutherford, all the protons and about half the electrons are packed very close together to form a central positively charged nucleus, round which the remaining electrons circulate, somewhat like planets round a sun. All the spectroscopic and chemical properties of the atom depend on the positive charge on the nucleus, which is the excess of protons over electrons. This is clearly the number of planetary electrons in the neutral atom; it is called the *atomic number* and is actually the number of the element in the periodic classification—1 for H, 2 for He, 3 for Li, and so on. The whole-number weight of the atom, on the other hand, will be the total number of neutral pairs of protons and electrons it contains. This is also the number of protons in its nucleus, and is called the *mass-number* of the atom—1 for H, 4 for He, 6 and 7 for the isotopes of Li, and so on. Atoms are isotopic, that is, belong to the same element, when their nuclei have the same net positive charge, but they may have a different total number of protons, and so different weights.

We picture the atom as consisting of a central nucleus and an outer system of electrons, but when we come to inquire into the dimensions of the electrical particles themselves in relation to the dimensions of the atoms they compose, we are faced with a very surprising result. The protons and electrons are infinitesimal compared with the atom. To convey any direct idea of the numerical relations is almost hopeless, and were we to construct a scale model of the atom as big as the dome of St. Paul's, we should have some difficulty in seeing the electrons, which would be little larger than pin heads, while the protons in the nucleus would escape notice altogether as dust particles invisible to the naked eye. If we represent the nucleus of a helium atom as the size of a pea, its planetary electrons would be about a quarter of a mile away. Experimental evidence leaves us no escape from the conclusion that matter is empty. An atom, even of so heavy an element as lead, is as empty as the solar system and only occupies the spherical space we allot to it by virtue of the rapid and continuous rotation of its outer electrons. Led by the knowledge that under certain conditions these outer electrons could be stripped from the atom, and the nuclei thereby enabled to approach closer to each other, Eddington was able to predict that in certain stars matter could attain a density thousands of times greater than the greatest we know. This prediction has been strikingly verified by recent observations on the companion of Sirius, which at the same time have afforded another signal triumph for Einstein's relativity theory.

We have heard a good deal of loose talk in recent years of "splitting" the atom. Whenever you draw your fountain pen from your pocket you split countless millions of atoms in the sense that you violently tear

planetary electrons away from them, by the friction between the ebonite and the cloth. This form of splitting is called ionisation. In it the atom suffers no sort of permanent injury. It simply captures the first electron it can to replace the one it has lost, and after notifying the world at large of its recovery by a wireless signal, it goes on exactly as before. In such a solid as copper, the exchange of electrons from one atom to another can be effected with the greatest freedom, and it is the passage of these loose electrons which constitutes the ordinary electric current. I suspect that the high conductivity of the negative glow, and of flames, is due to an exchange of a somewhat similar kind.

I mentioned the despatch of a wireless signal sent by the atom on repair of its injury. The type of this radiation depends on the extent of the damage done. For superficial effects it is light and radiant heat: for deeper and more violent effects it is X-rays. The displacement of the innermost and most tightly bound electrons gives rise to the hardest X-rays. The tightness of binding depends on the nuclear charge, so that for the emission and absorption of the hardest rays the heaviest elements must be employed. This property of the atom has already been dealt with by Sir Oliver Lodge in his address two years ago. It is to be emphasised that in all such cases we are only concerned with the outer electrons. With the nucleus it is a very different state of affairs. To dislodge any part of this requires violence of an altogether higher order, but if it is done the whole atom is changed, and changed permanently. This is no longer ionisation but transmutation.

TRANSMUTATION OF THE ELEMENTS.

Transmutation of the elements, so long sought by the alchemists, takes place spontaneously in the radioactive atoms, the nuclei of which are unstable and periodically eject helium nuclei and electrons, which are the well-known alpha and beta rays. Several claims of artificial transmutation of elements have been made recently in serious scientific journals. I will deal with the more doubtful ones first. Three years ago it was stated that helium was formed when a tungsten wire was deflagrated by an intense discharge. Sir Ernest Rutherford pointed out the extreme improbability of any disruption of the tungsten nucleus under these conditions, and a careful repetition of the experiments, with greater precautions, proved that he was right. Quite recently a claim has been made that helium has been produced by transmutation in a vacuum tube discharge. If true, this would be the greatest discovery in history, but the detection at the same time of neon, another atmospheric gas, is, to my mind, a very suspicious circumstance, and when these alchemists seriously suggest that success or failure may depend on the use of a particular form of obsolete make and break, my scepticism is increased.

A much more interesting case is that of the liberation of gold from mercury by electric discharge, even in an ordinary mercury vapour lamp. Here similar experimental results have been obtained by several investigators in different parts of the world, and the quantities of gold produced are remarkably large—large enough as we shall see to dissipate the hope, so confidently expressed, that it is formed by transmutation of the mercury atoms owing to the addition of an electron to

their nuclei. This claim was supported, I confess much to my surprise, by a well-known authority, on the ground that since the nucleus is positively charged, it would be quite easy to fire an electron into it. This is pushing the analogy of the sun and planet system to unjustifiable length. We know that a planet directed towards the sun would actually fall into it, but if every time an electron was directed towards a nucleus it fell into it and was absorbed, how could matter have a permanent existence at all?

We know there must be some mechanism in Nature which prevents such a collapse taking place in this simple manner. Even if we grant the theoretical possibility, there are still fatal practical objections. The addition of an electron to the nucleus of one of the isotopes of mercury will turn it into an atom of gold, but cannot alter its weight appreciably. Now the atomic weight of the so-called artificial gold has been determined by Hönigschmid, and agrees within experimental error with the value 197.2 assigned to ordinary gold. Quite recently, by means of a new and more powerful mass-spectrograph, I have been able to resolve the isotopes of mercury, and so determine its composition, which was previously in some doubt. I find that it consists of 198, 199, 200, 201, 202 and 204. There is no isotope 197 previously suspected. This fact, combined with the atomic weight, makes it quite certain that no transmutation of the kind claimed could produce the gold found. This is ordinary gold which must have been present in the mercury from the start. I understand that this view has now been shown to be right by the failure of the experiment when sufficient care is taken to eliminate all traces of gold from the mercury beforehand.

Unless our views on the structure of nuclei are very wide of the mark, failure in such experiments is inevitable, for the forces employed are ludicrously inadequate to cause disruption. The work of Rutherford, Chadwick, Ellis and others leaves no doubt that just as the dimensions of the nucleus are almost inconceivably small—the radius of that of aluminium is probably less than 4×10^{-13} cm.—so the forces binding together its component parts are gigantic and to be measured in millions of volts. Such forces are not yet available in the laboratory. They are, however, provided, on an atomic scale, in the form of the alpha particles shot out of radioactive atoms, and with these Rutherford has succeeded in producing real and definite transmutation. The method consists in bombarding the atoms with the swiftest alpha particles, which are helium nuclei with a velocity of more than 100,000 miles per second, which corresponds to an energy of many millions of volts. In order to effect a disintegration, these projectiles must make a direct hit on the nucleus. When this happens in the case of most elements lighter than potassium, a proton is dislodged from the nucleus, which is thereby transmuted into another element.

These observations have recently been strikingly confirmed by Blackett, who, using the beautiful Wilson fog-track method, has actually succeeded in photographing the disintegration of nitrogen nuclei struck by swift alpha particles. As I have already pointed out, the dimensions of the nucleus are minute compared with those of the atom. It can be calculated that an alpha particle colliding with an atom will only hit the nucleus

once in about ten thousand million collisions, so that although each alpha particle makes about 200,000 collisions in completing its track, a very large number of photographs had to be taken. Actually some 400,000 tracks were photographed and eight disintegrations detected. In these the thin track of the dislodged proton could be clearly seen, and a somewhat unexpected feature brought out is that in each case the projectile is retained by the target. The nitrogen nucleus loses one proton but captures the helium nucleus fired at it, and so would appear to become an isotope of oxygen of atomic weight 17. No such body is known in Nature, which suggests that the atom so formed is not permanently stable.

ATOMIC ENERGY.

In the possibility of artificial transmutation lies the hope of one day releasing the so-called "atomic" energy. The whole-number rule is not mathematically exact, and it has been shown by direct measurements on the mass-spectrograph that an atom of helium, which consists of four protons, two nuclear electrons and two planetary electrons, weighs nearly 1 per cent. less than four atoms of hydrogen, each of which consists of one proton and one electron. The number of particles is identical, and the change of mass is ascribed to the different way they are arranged, and is called the packing effect. The theory of relativity tells us that mass and energy are interchangeable, and that if a mass m is destroyed, a quantity of energy equal to mc^2 is produced, where c is the velocity of light. Hence, if we could transmute hydrogen into helium, we should produce energy in quantities which, for any sensible amount of matter, are prodigious beyond the dreams of scientific fiction. For one gram atom of hydrogen, that is the quantity in 9 c.c. of water, the energy is

$$0.0077 \times 9 \times 10^{20} = 6.93 \times 10^{18} \text{ ergs.}$$

Expressed in terms of heat, this is 1.66×10^{11} calories, or in terms of work 200,000 kilowatt hours. In a tumbler of water lies enough power to drive the *Mauretania* across the Atlantic and back at full speed.

Here we have at last a supply sufficient even for the demands of astronomers; indeed, there is now little doubt that the vast supply of energy radiated by the stars can be kept up for centuries by the loss of an insignificant fraction of their mass. Whether this process is a degradation of hydrogen into helium, or the complete annihilation of matter by coalescence of its protons and electrons, is at present unknown. How long it will be before man is able to effect transmutation of matter into energy, and to what uses he will put such vast potentialities, are interesting subjects for debate. If scientific knowledge maintains its present rate of progress, the balance of probability is in favour of ultimate success, but this appears so far off that almost any speculation may be permitted. It may be that the operation once started is uncontrollable, and that the new stars which flare out from time to time in the heavens are but an intimation broadcast to the universe, of the first successful large-scale experiment on a far-distant world. It may be that the highest form of life on our planet will one day discover supreme material power, or cataclysmic annihilation, in the same ocean wherein, we are told, its lowest forms originally evolved.

Physics in Agriculture.¹

By Dr. BERNARD A. KEEN.

THE study of the physical properties of soil has a fundamental place in the application of science to agriculture. It occupied an important position in the early days of agricultural science, and, after a lengthy eclipse in the latter half of the nineteenth century, when Liebig, Lawes and Gilbert, and others were establishing the modern agricultural chemistry and biology, it again came into prominence, owing to the recognition of the colloidal properties of the soil. The older concepts have been examined from this point of view, and it appears that the soil must be regarded not as a mass of comparatively inert grains over which water is distributed in a thin film, but as particles the surface of which is coated with colloidal material. The composition of this material is complex. It is a mixture of organic and inorganic substances derived from the decomposition of organic matter, and the weathering of clay, respectively, and it modifies very largely the deductions on the relations between soil and its moisture content made from the older hypothesis.

A soil can be easily divided into a few groups or fractions of different average size, depending on the velocity of fall in water. This process is known as mechanical analysis. It is a routine procedure in a soil survey and, combined with ecological and meteorological observations over the area, enables the expert to suggest improvements in the agriculture. In the case of undeveloped countries, this examination is essential if the agriculture is to be built up on sound lines. A striking example of the value of such a survey is afforded by the recent classification of Africa into areas according to agricultural potentialities, made by two American workers. The information was limited and the divisions are only approximate, but the very fact that it was possible to make them at all on such restricted information, shows the power and flexibility of the method.

In research investigations, the simple procedure of mechanical analysis must be replaced by more exact methods, in which the distribution of particles is expressed as a continuous function of the effective radius. One method depends on measuring the gradually increasing weight of particles settling on a pan immersed in a suspension of the soil in water, and from these data the distribution curve can be derived mathematically. The method is not yet perfect, because the settling particles that would eventually reach the liquid under the pan are naturally caught by the pan, whereas those in the annular space fall freely. In consequence, a

density difference is established which sets up currents in the liquid, and the particles are deflected from their proper course.

For the purpose of this work, and for other studies, the Soil Physics Department at Rothamsted has developed an automatic and continuous recording analytical balance, illustrated in Fig. 1. A magnet is suspended from one arm, and the current through the solenoid is adjusted to keep the balance in equilibrium. The adjustment is automatic and is effected by using the motion of the balance beam away from equilibrium to complete subsidiary circuits which operate electromagnets controlling clockwork mechanism, that moves a sliding contact backwards or forwards along a slide wire. The current through the solenoid is, therefore,

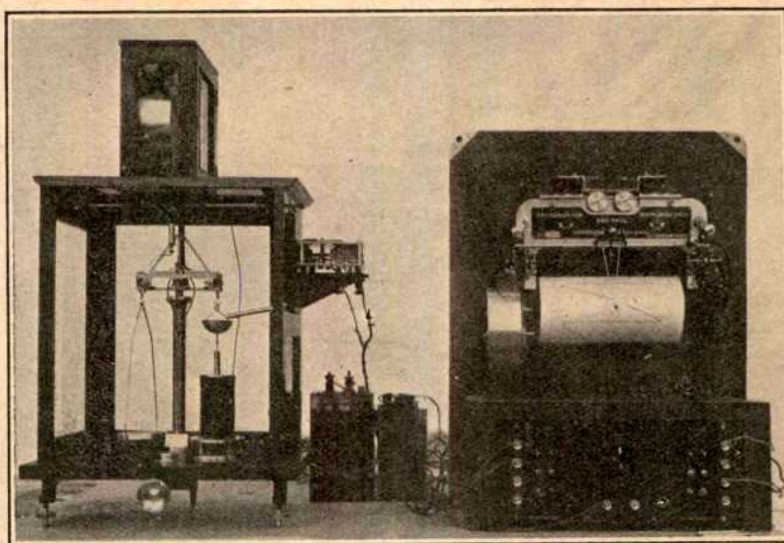


FIG. 1.—The Odén-Keen automatic recording balance.

changed by the requisite amount. When the contact reaches the end of the slide wire, a third circuit is completed, and a phosphor bronze ball of known weight is automatically added to the magnet arm. The sliding contact rapidly returns to its zero position and the cycle of operations recommences. The resistances are so arranged that the relation between weight and length of slide wire across which the solenoid is connected is practically linear. Hence a pan attached to the sliding contact and resting on a rotating drum, gives a continuous record from which the change in weight can be inferred.

The treatment of the flow of water through soil, in an analogous manner to the flow of heat or electricity through conductors, presents considerable difficulties, because the quantities corresponding to conductivity and potential (which for heat and electricity are practically independent of external conditions and current density) are not independent of the moisture content, the state of packing and the colloidal content of the soil. Although the difficulties of theoretical and practical investigation are great, much attention has

¹ Based upon a lecture on "The Physicist in Agriculture, with Special Reference to Soil Problems," being the ninth of the public lectures on physics in industry, arranged by the Institute of Physics, and delivered on November 25.

been devoted to the problem because of the practical applications, especially in areas under irrigation, where it is essential to make the best use of the available water, and yet to avoid the concentration of deleterious "alkali" on the soil surface resulting from an excessive upward movement of soil moisture. In regions with adequate rainfall, recent experiments at Rothamsted indicate that the depth from which water can ascend by capillary action, and thus become available for plant growth, is not very great. This emphasises the value of those cultivation operations designed to conserve the moisture in the upper regions of the soil.

The importance of the soil water relationships resulted in many additions to the original broad

closely related to the behaviour of the soil under the action of cultivation implements, and they can be readily interpreted on the assumption that the colloidal material in soil forms a coating over the larger inert grains. Thus, the shrinkage of a plastic mass of kaolin, which normally follows a different course from that of soil, can be made closely to simulate the latter if a small amount of silica gel is previously precipitated on the surface of the kaolin particles.

In the field, the integrated effect of plasticity, cohesion, and surface friction between soil and a metal surface may be measured by a dynamometer in the hitch between the implement and the horse, or tractor. The drawbar pull thus recorded is found to vary con-

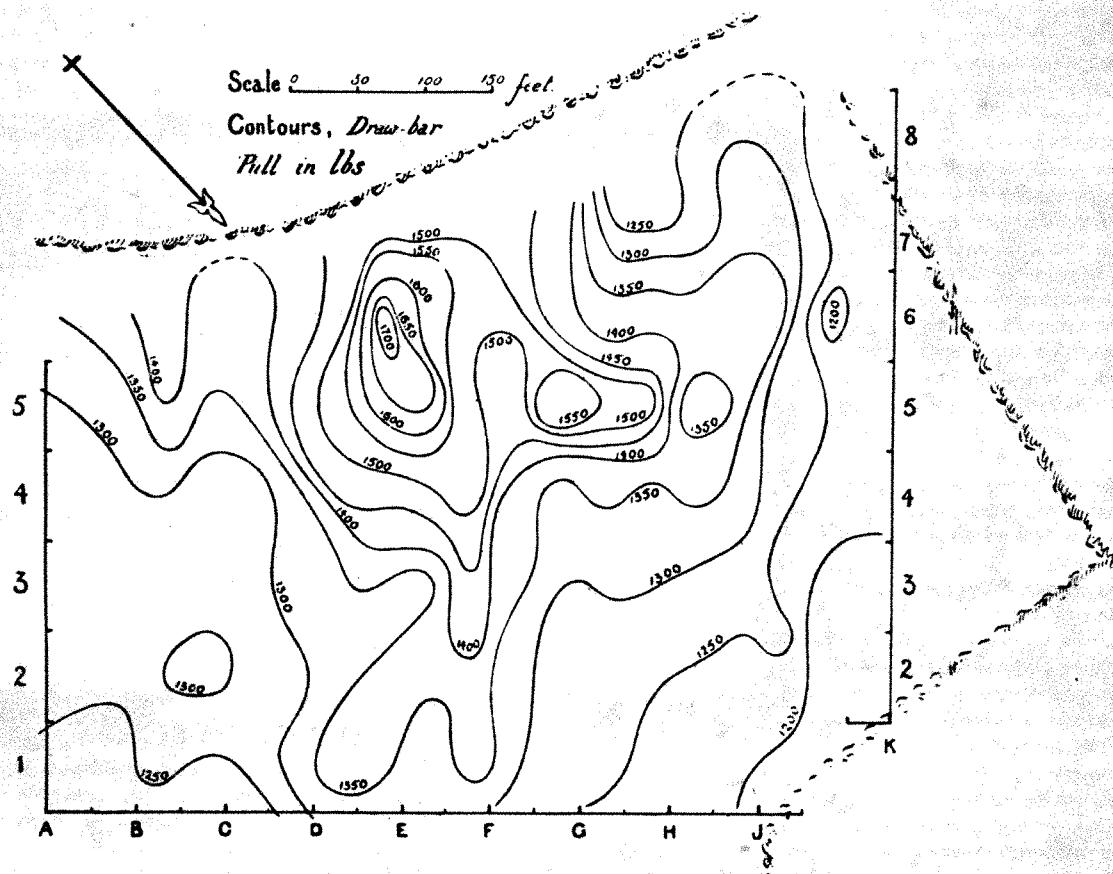


FIG. 2.—Lines of equal draw-bar pull over a supposedly uniform field.

divisions of soil moisture into gravitational, capillary, and hygroscopic moisture. They were based on the assumption that the soil grains could be regarded as inert, but the recognition of the colloidal properties of soil has destroyed the validity and physical significance of these additions. Further, it has been shown that the vapour pressure of moist soil reaches its saturation value at a moisture content well below the values obtained for the so-called "equilibrium points" of soil moisture. This suggests that the moisture relationships are best expressed by other properties of moist soil, such as cohesion and plasticity, because variations in these factors are to be expected at moisture contents above the value for saturation vapour pressure. These properties have the further advantage that they are

siderably even on areas that to visual inspection are quite uniform. In a comprehensive field test, variations of more than 30 per cent. were found, even when the average drawbar pull of plots 66 ft. $\times$ 33 ft. was considered. For individual furrows the differences were much greater. The results are well illustrated by Fig. 2, where the "contours" of equal drawbar pull have been mapped from the results on a scale plan of the field. This variation is of obvious importance in competitive or comparative implement trials, for which, as an essential preliminary, a dynamometer survey should be made of the selected area. Other experiments show that the variations from point to point persist unchanged from season to season, and are not sensibly affected by manuring, with the exception of organic

manures. The variations in drawbar pull figures are also closely related to the amount of drainage and to the early stages of plant growth.

It is found that the drawbar pull is comparatively unaffected by speed of cultivation. Thus for tractor ploughing, an increase from $2\frac{1}{2}$ to 4 miles per hour, which would mean a 60 per cent. greater area ploughed in a given time, only involves a 7 per cent. increase in

drawbar pull. It is improbable that the cost of the extra fuel necessary to give this increased pull would be more than a small fraction of the saving in labour costs due to increased speed of work. The design of tractors run at higher speeds without undue wear and tear, and of implements to perform satisfactory work at high speeds, should present no insuperable difficulties.

The Geology of the New Mersey Tunnel.

By Prof. P. G. H. BOSWELL, University of Liverpool.

ON December 16 H.R.H. Princess Mary inaugurated the work of excavation for the new tunnel under the River Mersey, sanctioned by Parliament last August. As is well known, a railway tunnel of invert form and 26 ft. in width has long been in existence; it was begun in 1881 by the Mersey Railway Company and completed some years later. The new tunnel is to be a highway and will be the largest of its kind. The major part of the tube will be circular in section, with an internal diameter of 44 ft., the road-way being constructed so as to take fullest advantage of the width. It will thus provide a four-way road for slow and fast two-way traffic, with side-walks of about 4 ft. for purposes of traffic control, etc. The cost of the tunnel is to be 4,750,000*l.*, half of which will be provided by the Ministry of Transport in view of its highway character.

The line of the tunnel is to be roughly parallel to and about 150 yards north of the existing tunnel, its direction being about N.E.-S.W. The total length of tunnel will be rather more than two miles, of which about three-quarters of a mile will lie beneath the river.

At the Birkenhead end the entrance is to be near the Birkenhead Woodside Railway Terminus, and thus close to the docks. A suitable gradient of 1 in 30 will be obtained by a spiral descent. On the Liverpool side the tunnel will bifurcate, the northern branch ascending by a spiral gradient of 1 in 30 to the docks north of the pier-head, and the southern branch by a fairly straight stretch, of gradient 1 in 20, to an entrance in the heart of the city.

Throughout its course the tunnel will lie in Triassic sandstone and the overlying glacial deposits. On the Birkenhead side, under the River Mersey and for about 550 yards from the dock-walls on the Liverpool side, the rock belongs to the Middle Bunter Sandstone (or "Pebble-beds," though pebbles are scarce in the district). The beds dip at a low angle eastwards. The last 330 yards of the southern branch on the Liverpool side may be expected to lie in the Upper (Soft) Mottled Sandstone of the Bunter, which is here thrown down by a fault against the Middle Sandstone.

The latter is a firm, well-bedded rock, excellent for purposes of excavation, for it will stand well; the Upper Sandstone is rather soft. Both rocks, however, are renowned for the copious water-supply yielded by them.

It will be remembered that the Mersey estuary narrows considerably where Birkenhead and Liverpool

are situated. Indeed, a rock-bar is responsible for the consequent ease of communication between those ports. Higher up the river, the overburden of glacial drift thickens, and, as the late T. Mellard Reade demonstrated, a deep channel of drift occurs at Widnes. As a result of his study of minor channels of drift in the area of the Liverpool and Birkenhead docks, Mellard Reade declared, before the Mersey railway tunnel was cut, his belief that they drained into the main buried channel, which would thus extend down the Mersey estuary, through the rock-barrier to the sea. He claimed, with good reason as the sequel showed, that geologists could pre-see, and warned the engineers that the channel of drift must be expected in the course of their operations. The channel was struck on the down-grade portion of the tunnel about 90 yards from the Liverpool side, and 44 ft. below the present bed of the Mersey, its base being closely 95 ft. below O.D. An unavailing attempt was made to avoid it, but fortunately the lowest 6 ft. of the channel (which was cut into for a length of about 66 yards) proved to be a stiff purple Boulder Clay. This clay yielded an excellent roof, and, unlike the sandstone, gave no trouble from water.

Another prediction, even more puzzling to those to whom the geology was not familiar, was that of the late G. H. Morton of Liverpool, who drew a geological section across the Mersey estuary and inferred the presence of a north-south fault with a westerly down-throw, under the bed of the river. This fault was struck in due course near the place assigned to it by Morton.

Trial-borings in the roof of the railway tunnel under the middle of the river proved a thickness of at least 15 ft. of Bunter Sandstone. The level of the top of the new tunnel in the part beneath the river will be nearly the same as that of the existing tunnel (approximately 106 ft. below O.D.). With the information made available by Mellard Reade and Morton, and the precision given to it by the excavations for the railway tunnel, and with the knowledge which has accumulated since (the officers of H.M. Geological Survey having re-surveyed the area just before the War), the engineers of the new enterprise will be fully forewarned of possible difficulties. But nobody, least of all a geologist, would care to predict the exact course, changes in depth, or lithological variation from clay to sand or gravel in a buried channel of glacial drift. There is no reason to doubt, however, that the new undertaking will prove successful.

Obituary.

PROF. A. FRIEDMANN.

IT has been briefly announced that Prof. Alexander Friedmann, director of the Central Geophysical Observatory, Leningrad, died of typhus fever on September 16, 1925, at the early age of thirty-seven years.

It is remarkable that under the auspices of the Academy of Sciences of Leningrad, which has recently celebrated its two-hundredth anniversary, the keen interest of Russia in scientific activities has been maintained throughout the stress and strain of war and revolution. The chief centres of geophysical activity before the War were the Central Physical Observatory at Leningrad and the Aeronautical and Magnetic Observatory at Pavlovsk (now Slutsk). The latter found itself between two armies after the revolution; but, with considerable difficulty, the work was maintained. From these centres the vast meteorological organisation of the Russian Empire had been controlled. It was naturally hampered a good deal by war conditions, but is being rapidly reinaugurated. After the death of Prince Boris Galizin, provisional arrangements were made for the scientific direction of the organisation; Prof. Obolensky was director for some time, and up to February of this year Prof. Weinberg was in charge.

At the congress on Applied Mechanics at Delft in April 1924 Russian representatives were present, and the number of papers which were offered overflowed the meeting-room and were made available in manuscript in the reading-room of the congress. Many of the papers were presented by Prof. Friedmann. He had graduated in 1910 at St. Petersburg, studied aerodynamics under Prof. Bjerknes in Leipzig, joined the Observatory at Pavlovsk, volunteered for the War as observer in the flying corps, was promoted to take charge of the aerological service of the army, and in 1918 became professor in the University of Perm. But in 1920 he returned to Leningrad as senior physicist at the Central Observatory, re-named Geophysical, of which he became director early in 1925. "A man of extraordinary mathematical capacity, he deliberately forced himself to experimental work in order to verify his results. He was entirely devoted to science; he worked hard himself and claimed hard work from his colleagues." In 1924 he started at the Observatory a new periodical, *The Journal of Geophysics and Meteorology*, wherein geophysical papers are printed in Russian with a brief summary in one or other of the foreign languages. His principal contributions to science are on "The Vortical Motions of the Atmosphere" in a periodical which he started as professor at Perm; "On Vortices in Liquids with variable Temperature," which he presented to the Mathematical Society of Kharkov; "On Differential Equations for Turbulent Motion of a Compressible Fluid," at the Congress of Applied Mechanics at Delft. He also contributed to modern mathematical physics papers on the curvature of space.

During Friedmann's short tenure of the directorship of the Central Geophysical Observatory he reanimated the organisation in an extraordinary manner. He was to have come to London for the meeting of the Upper Air Commission in April last; but at the last moment

found himself unable to leave Leningrad. His activity was, however, effectively represented by Dr. Moltchanoff, the director of the Aerological Observatory at Slutsk. Almost every phase of the subject was covered by one or other of the series of papers presented in Friedmann's name or in those of his colleagues. Since that meeting many letters have been received from him about the establishment of geophysical observations in various parts of Russia; the last of them, dated July 25, announced the creation of a geophysical observatory at Jakutsk as a local branch of the Central Geophysical Observatory, meteorological and aerological at first, with the intention of its becoming astronomical, optical, and magnetic in time.

Friedmann's untimely death is a serious loss for Russian geophysical science; but regard for his memory will certainly impel his successors to carry on the work which excited his unbounded enthusiasm.

NAPIER SHAW.

MR. W. R. DYKES.

WE regret to record the untimely death of Mr. William Rickatson Dykes, secretary of the Royal Horticultural Society, at the early age of forty-eight years. Motoring with his wife near Woking, his car skidded, collided with a lorry, and he was thrown out, sustaining severe injuries to his ear and right arm. Attempts to save the latter failed, and he died of syncope, following the amputation of his arm at the shoulder, on Tuesday, December 1.

Mr. Dykes was born on November 4, 1877, the second son of Mr. Alfred Dykes, and educated at the City of London School, at Wadham College, Oxford, where he took classical honours, and the Sorbonne. He became an assistant master at Charterhouse in 1903, and remained there until the end of 1919, when he was elected to succeed the late Rev. W. Wilks as secretary of the Royal Horticultural Society. Under his secretaryship the Society has continued the growth started in 1888, and Mr. Dykes had recently taken a considerable part in furthering the plans (which are now well forward) for the building of a new and larger hall for the Society's meetings. His name, however, will be remembered, not so much for his work as a teacher, or as secretary of the Royal Horticultural Society, but chiefly for his devotion to the genus *Iris*.

Mr. Dykes had remarkable powers of concentration, an inquiring mind, a love of attempting to overcome difficulties in the cultivation of his plants, and facility in expressing himself in writing; and all of these he brought to the service of his favourite plant. While at Charterhouse he collected and grew all the species of *Iris* he could procure, and studied them minutely from both the cultural and the botanical sides. The mantle of Sir Michael Foster fell upon him, and one might almost say that Dykes had a double measure of the spirit that imbued that great iris lover. He was not content to follow authority, and took the utmost pains to investigate every small point that cropped up. He had correspondents wherever irises grew wild, and made himself acquainted with more than one foreign language in order to put himself in direct touch with first-hand information gathered by those

familiar with the plants in their native homes. He went to their native homes himself so far as he could in his vacations, and he made a fuller use of the garden in investigating relationships between diverse forms than probably any one before him, not only in this genus, but also in any other. His enthusiasm for the genus infected many another, and his many writings in gardening papers helped to spread the knowledge he had gained far and wide. In 1913 he published his great monograph on the genus, and it at once took its place among the best monographs upon a single genus which had appeared anywhere in the world; and in addition to this he wrote two other smaller books on the Iris family, which have gained wide appreciation. More recently, two other genera have competed in his affections with the Iris, and in the garden at Sutton Green, which he had recently acquired, he had collected very many species of tulip and of crocus, and he intended to study the tulip as he had the iris.

His last book was a translation of "La Taille Lorette," which will help to make Lorette's methods of pruning more familiar to English readers.

Dykes showed how invaluable an aid the garden may be in elucidating problems in relationship. He enriched the genus he made his own by raising many fine varieties, and he was doing the same with tulips.

The Veitch memorial medal and the Victoria medal in horticulture were both conferred upon him, largely on account of his work upon irises, the latter only a few days before his death.

We tender to his wife, whose interest and skilful pencil so greatly helped him, our deepest sympathy.

SIR ATHELSTANE BAINES.

WE regret to record the death of Sir Jervoise Athelstane Baines, C.S.I., the distinguished authority on Indian ethnography, which took place at Kidlington, Oxford, on November 26. Sir Athelstane Baines was in his seventy-ninth year, having been born on October 17, 1847. He was the son of the Rev. Edward Baines, and was educated at Rugby and Trinity College, Cambridge. He joined the Indian Civil Service in the Bombay Presidency in 1870, when the first attempt to enumerate the Indian population, which extended from 1867 to 1872, was in progress. In the one-day enumeration of 1881, Baines was deputy superintendent of the census in the Bombay Presidency. The value of his work in this capacity led to his appointment as superintendent for the whole country in the next decennial census of 1891. The task of organisation occupied him for three years. This and his general survey of the results summarising the various State and Provincial reports, which was at once widely recognised as the work of a brilliant ethnographer and statistician, laid the foundations for much of the work of his able successors, Sir Herbert Risley, Sir Edward Gait, and Mr. Marten. Indeed to his inspiration, directly or indirectly, can be traced much of the admirable ethnographical work which has been done by members of the Civil Service. As a result of his census work, Baines was appointed to prepare the Decennial Report on Moral and Material Progress to 1891, and in 1894-5 to

be secretary of Lord Brassey's Opium Commission. He was awarded the C.S.I. and retired in 1895.

On settling in England, Baines continued his ethnographical work, which included studies from various aspects of the three decennial Indian enumerations which have followed his retirement. He was a valued contributor to the proceedings of the Royal Statistical Society, of which he was president in 1909-1910. He also took part in public administration, being elected an alderman of the County of London and a member of the Oxfordshire County Council for 1917-1922. He was knighted in 1905.

DR. HAROLD W. NICHOLS.

DR. HAROLD WILLIAM NICHOLS, a radio research engineer of Bell Telephone Laboratories, died on November 14 at his home in Maplewood, New Jersey. Dr. Nichols was born in Iowa on February 23, 1886. He received his education at Armour Institute of Technology, Chicago, and at the University of Chicago. In July 1914, he joined Bell Telephone Laboratories in New York City. He rapidly achieved distinction in the radio research activities of that organisation, and during the War, he was in charge of its radio work. During recent years he has been identified prominently with the investigations of ship-to-shore radio telephone service and of short waves in radio communication. He was recognised as an authority on "fading"; his papers on this phase of radio are distinct contributions to the art. He took a leading part in the transatlantic radio telephone tests in 1923, and for a lecture on this subject received the Fahie Premium from the Institution of Electrical Engineers. He had twenty inventions pertaining to the radio art to his credit and nine applications are now pending.

Dr. Nichols was a member of the American Institute of Electrical Engineers; the American Mathematical Society; the American Physical Society; the Institute of Radio Engineers; and the Sigma Xi and Eta Kappa Nu fraternities. His associates in the Bell Telephone Laboratories regard his death as a distinct loss to the profession as well as a great personal loss to themselves. He was a man of pleasing personality; an efficient and untiring worker, noted for his judgment and insight into all phases of the art of radio.

WE regret to announce the following deaths:

Dr. Johan August Brinell, Bessemer medallist in 1907 of the Iron and Steel Institute, whose name is associated with the hardness testing of materials, on November 17, aged seventy-six years.

Prof. Joseph Brough, formerly professor of mental and moral science at the University College of Wales, Aberystwyth, and the author of "The Study of Mental Science," on December 7, aged seventy-three years.

Dr. Edmund Knecht, associate professor of technological chemistry in the University of Manchester, editor of the *Journal of Dyers and Colourists* and author of numerous works on bleaching, dyeing and other aspects of textile manufacture, on December 8, aged sixty-four years.

Current Topics and Events.

THE National Academy of Sciences and the National Research Council of the United States announce the forthcoming publication of the International Critical Tables. The first volume is to appear early in 1926 and is to be followed by four other volumes, comprising altogether about 2500 pages. The tables have been edited by Dr. Washburn, with Drs. Dorsey, West, Bichowsky, and Klemenc as assistant editors, who have had the co-operation of some three hundred experts in different parts of the world, but mainly drawn from the United States. According to the instructions to these experts, the tables are to differ in an important respect from many of the existing tables of physical and chemical constants. Instead of recording all or most of the determinations of a given constant which have been made, the co-operating experts were requested to give the most probable value of the constant after a critical consideration of all the determinations available. If this has been generally done with good judgment, the tables will be of great value to science. In a leaflet issued by the editors, the contents of the first volume, and the projected contents of the remaining volumes, are given. It is evident that very special attention is given to the needs of the technologist. The arrangement of the first volume is curious: an article on crystal structure is followed by articles on "dispersoidology, sweetening agents, odoriferous materials," and then by one on radioactivity. The published price of the set of five volumes is 60 dollars, but up to the appearance of the first volume early in 1926, members of scientific and technical societies, government departments, educational institutions, public libraries, etc., can subscribe at 35 dollars. The editorial expense of the tables, about 170,000 dollars, has been contributed by American industrial firms and benevolent foundations.

CORNELL UNIVERSITY, New York, has received an anonymous gift of 250,000 dollars, the income of which is to be used for the benefit and advancement of teaching and research in chemistry and allied fields. The gift is to enable the University to carry out a plan formulated by Prof. L. M. Dennis, Head of the Department of Chemistry, whereby prominent men of science will be invited to Cornell, each for one or two semesters, to present recent advances, and the methods and results of their own investigations. A private research laboratory will be placed at the disposal of the non-resident lecturer, who will thus be enabled to instruct a limited number of properly qualified students in his special field. The lecturers will be chosen so that different branches of chemistry or of allied sciences will be presented from term to term. The first incumbent of the lectureship in chemistry will be Prof. Ernst Cohen, professor of physical and inorganic chemistry in the van 't Hoff Laboratory at the University of Utrecht, Holland, who will be at Cornell during the second semester from February 1 until June 1, 1926. Prof. Cohen is the author of many books and pamphlets, comprising lectures and texts in the fields of inorganic and

physical chemistry, and biographical studies of various distinguished chemists, including his famous predecessor, J. H. van 't Hoff. The original investigations of Prof. Cohen and his co-workers cover a wide range of topics in thermodynamics, thermochemistry, electrochemistry and piezochemistry. Prof. Cohen's researches upon metastable and allotropic forms of the elements have attracted particularly wide attention.

PROF. S. PARKER SMITH, of Glasgow, read an interesting paper to the Institution of Electrical Engineers on December 3 on an "all-electric house." The house he described was the ten-roomed house in which he lives. The total annual cost for heating and cooking, hot water, lighting and power last year amounted to only 43l. 8s. although neither coal nor gas was used. Seeing that about 16,600 electric units were used the average cost per unit works out to about $\frac{1}{4}$ ths of a penny. In Glasgow arrangements can be made for heating water continuously between the hours of 11 P.M. and 8 A.M. at a price of $\frac{1}{4}$ ths of a penny per unit. In order to get good thermal storage it is necessary to design a well-lagged tank. Cork lining was found well suited for this purpose, the fall in temperature during the daytime being less than 1° F. per hour. The hot-water tank installed had a cubical capacity of 87 gallons, the average consumption per person for all purposes being about 15 gallons per day. The tank is fitted with a thermometer marked "high," "medium," and "low" to indicate in which position the switch has to be placed in the evening. In summer, it is sometimes only necessary to switch it on to the "low" position. This method of heating water economically is well known in districts which have a hydro-electric supply, and it is interesting to notice that it is making progress even when steam turbines are used. The Corporation of Greenock is offering energy for heating hot water during the night time at a farthing per unit. The scheme for ventilation adopted by the author was to draw fresh air into the rooms through air bricks behind the electric fires in the recesses, and to get rid of the vitiated air by means of a wooden grid let into the frieze and communicating with the flue in the external chimney. In all houses in or near towns, work is caused by the dirty or dusty air which surrounds them. It would therefore be better to use a small electric fan and a suitable filter to clean the air. The author points out that the absence of coal fires in a house may make it possible to dispense with one domestic servant, and so not only more than repay the total cost of the electric energy, but also lighten the domestic labour problem.

THE first ordinary meeting of the Electroplaters' and Depositors' Technical Society was held at the Northampton Polytechnic Institute on December 9, when Mr. S. Field read a paper on electrodeposition. He pointed out that there is a great need of organisation and co-operation by those engaged in the science and art of electrodeposition. The history of the art goes back for a hundred years, and the greatest

credit belongs to Faraday for his discovery of the laws of electrolysis. The great progress that has been made of recent years is due to the greater attention that has been given to scientific principles. The systematic research that has been made for addition agents has greatly improved the deposition of tin, lead, iron, cobalt, cadmium and chromium. The practical applications also have increased. A striking application is the copper matrices used for moulding gramophone records. Another recent application is the deposition of iron and nickel so as to repair the worn parts of machinery. When the metal deposited has to withstand mechanical wear, further investigation is needed. There are still too many unsolved problems in the practical processes, some of which would doubtless yield to organised research. The work should be undertaken by men who can devote their whole time to the problems. The position of the electroplating industry is unsatisfactory. There is neither standardisation of nomenclature nor of method. It is hoped to replace the many so-called formulæ for plating solutions by a few comparatively simple scientific formulæ. By organisation, research, standardisation and discussion it is hoped to advance the interests of the whole industry. Prof. F. G. Donnan, president of the Faraday Society, presided at the meeting and welcomed the formation of the Society. It was announced that permission to use rooms in the Northampton Polytechnic for meetings had been obtained.

A GROUP of activities of the Soviet Republics, referred to in a recent issue of the *Bulletin of the U.S.S.R. Society of Cultural Relations with Foreign Countries*, which is of special interest to anthropologists, is connected with the more primitive peoples of what was formerly the Russian Empire. An attempt is to be made to settle the nomads of Kazakistan Republic (Kirghiz Steppes) by the establishment of cultural and educational points which will serve as bases of settlement. The nomad Karagasses of S.W. Irkutsk Province, the remnants of the ancient Samoyed tribes who once inhabited the Upper Yenisei, and of whom not more than 500 are left, are to be protected and their culture adapted to modern conditions. Already, by being brought into the co-operative movement, they have been placed in a position to dispose of the products of their hunting expeditions to greater advantage. A Red Cross expedition has been sent out to study their conditions, social, economic, and sanitary, and will pay special attention to the possibilities of making available medical service. Further, a number of cultural bases are to be established among the Samoyeds, Ostyaks, Voguls, Tunguses, and other peoples of the north, which will provide education, medical and veterinary services, and shops for the supply of primary necessities. A special expedition has been sent to the basins of the Lena, Yenisei, and Obi, for the purpose of studying the life of, and conditions among, other small peoples of these areas. A report of the results of these activities will be awaited with interest. It is well known that conditions among these tribes and peoples have for long been bad, and it may be hoped that the material organisation of the

Soviets, of which the reports are not encouraging, may be equal to carrying out these measures of amelioration. On the scientific side, to be of any wide utility, much greater expedition in the publication of results than has been shown hitherto is urgently needed.

EARLY skating this winter in Great Britain coupled with the keen November frost and unusually early snow-falls, as well as the strong northerly gales, have given an impression that no such weather has occurred in November for many years, and some would take us back to 1890, when the great frost of 1890-91 commenced on November 25 and lasted until January 22. The Greenwich Observatory records published in the Registrar-General's returns enable a full survey of the daily temperatures for November. The mean for the whole month was $40^{\circ} \cdot 7$ F, which is $3^{\circ} \cdot 3$ below the normal for the thirty-five years 1881-1915. The mean of the maximum or day temperatures was $46^{\circ} \cdot 0$ and the mean of the minimum or night readings was $35^{\circ} \cdot 3$. In November 1923 the mean temperature at Greenwich was about 2° colder than this year. The maximum or day temperature was below 40° on 10 days, this year only on 5 days, and the minimum or night temperature fell to 32° or below on 12 nights in 1923 and only on 10 nights this year. The absolute minimum shade temperature in November 1923 was $22^{\circ} \cdot 7$, this year $24^{\circ} \cdot 9$. The mean temperature for November was also lower than this year in 1921, 1919, 1915, and 1910, but these are the only years since 1880. Snaps of cold weather still seem persistent, on December 4 the thermometer at Greenwich was below the freezing-point throughout the twenty-four hours, and on December 5 the minimum temperature was $21^{\circ} \cdot 4$, which is the lowest in December since 1920. An increase is shown in the deaths from influenza, the deaths in London being 22 in the week ending December 5, and in the hundred and five great towns of England and Wales the deaths numbered 100.

PRELIMINARY announcements have now been issued of the Kansas City meeting of the American Association for the Advancement of Science, to be held on December 29-January 2, under the presidency of Prof. M. I. Pupin, of Columbia University, New York. This will be the eighty-second meeting of the Association, but the first occasion on which it has visited Kansas City. General sessions for the whole gathering include the address of the retiring president, Dr. J. McKeen Cattell, on "Some Psychological Experiments"; the fourth annual Sigma Xi Lecture, by President F. D. Farrell, of the Kansas State Agricultural College, on "A Desert becomes a Garden"; an address by Prof. Dayton C. Miller, of the Case School of Applied Science, on "The Michelson-Morley Ether-Drift Experiment, its History and Significance"; the third annual Josiah Willard Gibbs Lecture of the American Mathematical Society, by Prof. James Pierpont, of Yale University, on "Some Modern Views of Space"; discussions on the rôle of science in education and on the relations of engineering to the fundamental sciences; and a lecture by Dr. F. R. Moulton, of the University of Chicago, on "The Origin and Evolution of Worlds." Popular citizens' lectures are also being arranged. The third annual

American Association Prize of 1000 dollars is to be awarded for "some noteworthy contribution to scientific advancement presented at the meeting" Last year this prize was divided between two scientific workers, but this will not be done in future. A publicity office for the release of news to the Press is being organised in association with Science Service, and a comprehensive exhibition of apparatus and books has been arranged.

THE library of the Chemical Society will be closed for the Christmas Holidays at 1 P.M. on Wednesday, December 23, and will reopen at 10 A.M. on Tuesday, December 29.

LIEUT.-GENERAL SIR WILLIAM FURSE, K.C.B., has been appointed Director of the Imperial Institute, in succession to Sir Richard Redmayne, who has been acting as Director during the period of reorganisation and amalgamation with the Imperial Mineral Resources Bureau. Sir Richard now becomes chairman of the Advisory Council of Minerals of the Institute. The appointment of Sir William Furse as Director is in accord with the recommendation of the committee of inquiry into the Imperial Institute, presided over by Mr. W. Ormsby-Gore, that the director of the Institute should be an administrator officer rather than a scientific or technical expert.

By virtue of the Importation of Plumage (No. 1) Order, 1925, the names of the Common Cormorant and the Common Shag have been added to the Schedule to the Importation of Plumage (Prohibition) Act, 1921, which contains the names of certain birds the plumage of which may be imported without licence. The Board of Trade accordingly desires it to be known that as from December 10 it will be possible to import the plumage of the above-mentioned birds without Board of Trade license.

THE following officers and new members of council of the Royal Physical Society of Edinburgh have been elected for the session 1925-26: *President*: Dr. James Ritchie; *Vice-Presidents*: Dr. Marion I. Newbigin, Prof. J. A. Thomson, Mr. Wm. Williamson; *Secretary*: Mr. H. Maxwell Vickers; *Assistant Secretary*: Prof. J. Russell Greig; *Treasurer*: Mr. Thos. V. Campbell; *Librarian*: Mr. J. Kirke Nash; *New Members of Council*: Mr. T. Cuthbert Day, Prof. T. Hudson Beare, Mr. P. F. Kendall, Prof. Donald C. Matheson, Rev. J. M. McWilliam.

PROF. A. P. KNIGHT, chairman of the Biological Board of Canada, writes that since his letter on "The Losses in Trout Fry after Distribution" appeared in NATURE of October 17, p. 573, he has had the report on the distribution and losses of trout fry for the past summer (1925). He states that 4000 were distributed in a brook on Prince Edward Island, and at the end of three months, only 27 per cent. of these were alive. The seining showed 300, more or less adult trout present in the stream, 80 fundulus, 31 salmon parr, and 15,000 two-spine stickleback. The presence of these fish natural to the stream, and the lack of adequate supply of natural food, probably accounts fully for the heavy loss of 73 per cent. of the total number distributed.

THE Norman Lockyer Observatory, Sidmouth, is offering a research studentship in astrophysics of the value of 150*l.* per annum for one or two years to a student with a knowledge of spectroscopy. The astronomical and laboratory instruments and material of the Observatory will be at the disposal of such a student for the purposes of practical work; while the large number of negatives of stellar spectra and other observational data which is available for study, together with the extensive library, will provide valuable material for more theoretical research work. The opportunity thus offered should be of great value to a post-graduate student who wishes to apply his knowledge to the study of astrophysical problems and to undertake research work in this subject. Further particulars can be obtained from Capt. W. N. McClean, 1 Onslow Gardens, S.W. 7.

A CHADWICK lecture on "encephalitis lethargica (sleepy sickness) in England" was delivered by Dr. Salusbury MacNalty on December 9. The lecturer said that this disease made its appearance in England in the spring of 1918 and has since become increasingly prevalent, no less than 5040 cases, with 1419 deaths, occurring in England and Wales last year. For practical purposes the disease is a new phenomenon, though certain epidemics in the past may have been examples of it. It is probably caused by a minute filter-passing micro-organism which causes an inflammatory process in the brain, to which the chief clinical features are due. The question of the evolution of the organism was raised, and the possibility was suggested that the central nervous system of man to-day is more vulnerable than in former centuries, owing to the fatigue and strain of modern life.

At the Court of Governors of the London Hospital on December 9, the Chairman of the Hospital announced that an anonymous donor had given the large sum of 50,000*l.* for the purposes of medical research in that institution. It is not yet known how the money will be spent. The material for investigation of disease is superabundant at the London Hospital, and it is to be hoped that part at any rate of the money will be expended in individual or concerted effort to solve some of the disease mysteries on the spot where the necessary material exists. It would, in our opinion, be a mistake to fritter away the money, as is often done, in giving grants to a number of young men to produce amateurish work. It is to be hoped that the London Hospital will eventually be able to give a good account of work done and results achieved through assistance afforded by the recent gift.

IN our issue of December 5, p. 828, we printed an announcement from *Science* that the triennial prize for 1925, for the best original work contributing to scientific advancement in the technical applications of electricity offered by the Fondation George Montefiore of Liège, had been awarded to Dr. J. B. Whitehead, of Johns Hopkins University, Baltimore. We have since received information showing that this was one of four awards. The jury of award decided that no memoir submitted merited the single prize of

22,500 francs. The prize was divided and awarded to Mr. F. Creedy, electrical and mechanical engineer, London, for papers on "Some Developments in Multi-speed Cascade Induction Motors" and "Variable Speed Alternating Current Motors without Commutators" (6000 francs); Prof. J. B. Whitehead (4000 francs); and to Mr. Checholowsky, electrical engineer, Antwerp, for his "Study on Operating and Releasing Times of Telephone Relays" (4000 francs). An exceptional prize (2000 francs) for the description of "A New Form of Converter" was awarded to Mr. Raymond Wilmotte, London, in virtue of article 5 of the Foundation permitting the jury to allot a prize to a thesis showing a new idea capable of important developments in electrical engineering.

THE London County Council publishes each year an Annual Report and volumes of Accounts, Estimates, Statistics, etc. These publications, however, do not appeal to the great mass of Londoners, and the Council is therefore publishing a series of booklets on "The London County Council and what it Does for London," of which that entitled "Public Health" (Hodder and Stoughton, Ltd., price 6d. net) has

recently been received. It deals in three chapters with main drainage, disease prevention, and treatment of disease, respectively, and gives a popular summary of what the Council has done and is doing for these aspects of public health. The booklet is well produced and illustrated, including a map showing the drainage system of London, and is very readable.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Test assistant at the Aeroplane and Armament Experimental Establishment, R.A.F., Martlesham Heath, Suffolk—Secretary to the Air Ministry, Aadalstr House, Kingsway, W.C.2 (January 4). Technical assistant for the Aerial Photographic Department—Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (January 9). A principal officer of the University of London—Secretary to the Senate, University of London, South Kensington, S.W.7 (February 1). Several men possessing good scientific training and technical experience—Secretary, Chilian Nitrate Committee, Friars House, New Broad Street, E.C.2.

Our Astronomical Column.

DAYLIGHT FIREBALL.—Mr. W. F. Denning writes: "On November 25 at 4^h 5^m P.M., when the sun was shining, a fine meteor was seen by several persons from Cornwall and Devon. It was directed from the south-west and disappeared in the north sky at a somewhat low altitude. It left a train as it passed with moderate velocity across the heavens, and with an estimated duration of 3 seconds. The meteor was quite conspicuous and appeared like a brilliant silver ball descending at an angle of about 35° as seen from Brentor, near Tavistock. The observations are not sufficiently exact for accurate computations to be made of the real path. The height was, however, probably about 77 to 41 miles and the velocity about 34 miles per second, radiant near β Bootis or, farther back in the line of flight, at Corona (233° + 34°). The position of the meteor was over the sea W.N.W. from Fishguard to over Carmarthen in S. Wales. This meteor was the second object of the class observed in sunshine this year, the previous one being on June 4, 4^h 10^m P.M."

THE ERROR OF NEWCOMB'S POSITION OF THE EQUINOX.—All the leading fundamental observatories agree in finding a large correction (amounting to a second of arc) to the position of the equinox given by Newcomb. Prof. Eichelberger and others have concluded that this error is increasing, and that Newcomb's rate of precession is wrong. Mr. R. T. Cullen, in *Monthly Notices of the Roy. Ast. Soc.* (vol 85, No. 9), gives reasons against this conclusion. He shows that when allowance is made for two changes of practice at Greenwich, the errors of equinox cease to be progressive. These changes are, the application of variation of latitude and the introduction of the travelling wire micrometer. The annual part of the variation of latitude causes a systematic shift of the equinox as deduced from observations of the sun, and the use of the travelling wire micrometer has altered mean personality of the observers in the solar observations. Removing the effect of these corrections from the recent observations, the error of Newcomb's equinox since 1851 is found to exhibit no progressive change. The reality of the present error of 1" in the equinox is not denied, but it is concluded to arise not from a wrong

rate of precession, but from the omission from the early solar observations of certain corrections which are applied to the recent ones.

COMETS.—The comets of Van Biesbroeck and Peltier-Wilk are still readily observable with small instruments, the latter being the brighter. The orbits of both comets are now known within narrow limits, that of Van Biesbroeck has been improved by Messrs. G. Merton and A. C. D. Crommelin, using their observations of the morning of December 10. The following elements (referred to the equator) are near the truth, but need slight adjustment.

$$\begin{array}{rcl} T & 1925 \text{ Oct. 1 } 9848 \text{ U.T.} \\ \omega' & 94^\circ 2' 43.1'' \\ \Omega' & 340 \quad 3 \quad 53 \quad 2 \\ i' & 70 \quad 18 \quad 20 \quad 6 \end{array} \left. \vphantom{\begin{array}{l} T \\ \omega' \\ \Omega' \\ i' \end{array}} \right\} 1925 \text{ } 0$$

$$\log q \quad 0.185531$$

An ephemeris from these elements is not yet available, but that from the Möller-Stromgren orbit will suffice for finding the comet with a little sweeping.

EPHEMERIS FOR OH.

	R.A.	R.N. Decl.	log r.	log Δ .
Dec. 18.	12 ^h 6.3 ^m	25° 48'	0.2615	0.1647
26.	12 2 8	23 50	0.2772	0.1538
Jan 3	11 56 5	22 0	0.2929	0.1431
11	11 47.3	20 17	0.3085	0.1329

The comet is now high enough for observation soon after midnight.

M. A. Schaumasse has discussed in detail the several returns of Borrelly's Comet in recent Nos. of the *Journal des Observateurs*. In No. 10 (Vol 8) he gives the predicted orbit for the present apparition

$$\begin{array}{rcl} T & 1925 \text{ Oct. 8 } 193 \text{ U.T.} \\ \omega & 352^\circ 25' 25.42'' \\ \Omega & 77 \quad 2 \quad 7.10 \\ i & 30 \quad 30 \quad 40.29 \end{array} \left. \vphantom{\begin{array}{l} T \\ \omega \\ \Omega \\ i \end{array}} \right\} 1925 \text{ } 0$$

$$\log q \quad 0.1424289$$

Period 6.885463 years.

Recent observations give a correction of +0.60 day to T.

Research Items.

ORIGIN OF ENGLISH GOTHIC STYLE—An interesting suggestion, which is not without attractions for students of racial psychology, was put forward by Mr. H. E. Irving Taylor to explain the "perpendicular" style in English Gothic in a paper presented to the Society of Engineers on December 7. After showing how "curvilinear" tracery has gradually developed from the desire to obviate the objection to unsightly spaces of bare stone which often exist when the original single lancet windows are gathered together as a composite window within one frame, he pointed out that in England the curves of the typical gothic window of France quickly gave way to the "rectilinear" or "perpendicular" framework. The chief explanation of this deviation from the natural development was undoubtedly a suddenly awakened predilection in England for Bible history told pictorially through stained glass. Pictures demand a straight rather than a curved framework, while a long or narrow-paned window best suited the human figure, and as windows increased in size owing to the diminished light given by stained glass, straight rather than curved lines were required to give strength.

THE RITE OF VIGIL OF THE OSAGE TRIBE—The thirty-ninth annual report of the Bureau of American Ethnology embodies an account by Francis La Flesche of one of the most important rituals of the Osage tribe. The rite of vigil is one of the "seven ceremonial divisions" of the tribal war rites that partake of the seven degrees. These religious rites were formulated during a long period of time in which, according to tribal tradition, the people were established, after a long period of military control, in a civil form of government under hereditary chiefs whose duties included keeping peace and order within the tribe. Two versions of the rite are here given, one belonging to the Puma gens and the other to the Peace gens. A number of songs are interspersed, of which translations are given as well as the music as recorded by Miss Alice Fletcher. The long and impressive ritual leads up to a climax in which an official friend of the initiate foretells the success or the reverse of the tribe from the manner in which a sacred bird lies on the ground as it falls from his hands. This supplicatory rite was employed on various occasions: first collectively by the whole tribe, when all the people cried to Wa-kon'-da, the great creative power, at dawn, noonday, and sunset; second, when the tribe determined on war, a man was chosen to perform the rite for the people as a part of the preparation; third, when a man lost a wife or near relation; fourth, when a man was being initiated into the mysteries of "weaving of the portable shrine," one of the seven degrees of the tribal war rites; and fifth, by the woman appointed to weave the shrine for him. This rite she had to continue all the time she was engaged in weaving, usually four days. On the other hand, the rite when employed in connexion with the death of a relative might last as long as two years.

THE BIOLOGY OF THE COMMON ROCK BARNACLE—Sven Runnström contributes (*Bergens Mus. Aarbok*, 1924-25), an account of the biology and development of the common rock barnacle of the sea shore, *Balanus balanoides*, based on observations made at the biological station of the Bergen Museum. The eggs are usually fertilised about the end of October and develop in the mantle chamber of the parent from which they swarm out as nauplius larvæ in the first half of March, moulting in a few hours to give rise to the second nauplius stage. How many further moults occur during the free swimming period—

which lasts about a month before the cypris stage settles down—was not ascertained. Early in April 1923 the author saw a large swarm of cypris larvæ and suggests that they had just issued from the parental mantle cavities—an exceptional condition. The development of the plates is carefully traced up to the condition in the adult, and a general survey of the formation of the plates in the Balanomorphs is given. The growth of the young Balanus is followed. A week after fixation and metamorphosis, the young Balanus is 1 to 2 mm. in diameter, by the end of June, 3 mm. in the middle of October, 4.5 mm., by the end of November, about 6 mm., and in March, *i.e.* at the end of the first year, 9 mm. in diameter. During the second year, greater growth in height occurs and little extension of the diameter. The ovary and testis of the hermaphrodite individuals are ripe in examples about a year and a half after metamorphosis, *i.e.* in October, and after the larvæ have escaped in the following March the majority of the parents die at the age of two years, but a few may live to the following autumn, *i.e.* to an age of three years, and produce another batch of eggs and young.

THE MOSQUITOES OF EGYPT—Under the foregoing title, Mr. T. W. Kirkpatrick, senior entomologist to the Egyptian Ministry of Agriculture, has recently published an extensive bulletin on mosquitoes (pp. xii + 224 + 24 plates + 2 maps. Cairo: Government Publications Office, 1925. 30 P.T.). The volume is the outcome of a request by the Anti-Malaria Commission of Egypt that a survey of the mosquitoes of the country be undertaken by the Entomological Section of the Ministry of Agriculture. In June 1924 Mr. Kirkpatrick was detailed for the work and was only given one year for its completion. During this brief period he has managed to gather together a good deal of useful information, and has paved the way for future control measures. Egypt is a country containing but few species of mosquitoes—a fact which is probably due to its isolation by barren deserts. The list of indigenous kinds now includes twenty-two species, or fewer than are met with in Great Britain. The larvæ and pupæ of these various species are all known and described, and practically all the waters wherein they are found gave pH values on the side of alkalinity. No correlation was found by Mr. Kirkpatrick between the pH values of the waters (which nearly all lay between 7.5 and 9) and the species of mosquitoes found to breed there. The most mosquito-ridden parts of Egypt are the oases of the Western Desert. Next in order would come the Fayum, followed closely by the Canal Zone (excepting Ismailia) and the Wadi Tumilat. The work of the Suez Canal Co., between the years 1901 and 1903, has resulted in the eradication of mosquitoes and the consequent disappearance of malaria from Ismailia and its immediate environs. This locality was once infamous as a most prolific breeding-ground for these insects.

A DISEASE OF DOUGLAS FIR—The Douglas fir (*Pseudotsuga Douglasii* Carr) is now extensively cultivated in Great Britain, and was at one time regarded as a tree remarkably free from serious epidemic pests. Unfortunately, it is losing its good reputation in this respect. One of its most serious enemies is a fungus now known as *Phomopsis Pseudotsugæ* Wilson, a fungus which has had many other names, but of which a full description, with notes upon its cultivation and upon the synonymy, has recently been published by Dr. Malcolm Wilson, reader in mycology, University of Edinburgh, as Bulletin No. 6 of the Forestry Commission. The disease is most

dangerous to young plants, so that infection in the nursery particularly has to be guarded against. Cankers are fairly frequent not far above ground level, and there is considerable reason to assume entry of the organism through a wound. Mechanical damage when planting, or during forestry operations generally, is evidently a source of danger, and the removal of dead wood and pruning operations need to be carried out with care. Rare instances of the disease are also recorded by Dr. Wilson for Japanese larch, European larch, and *Abies grandis* Lindl.

AIR-COOLED STORAGE ROOMS FOR APPLES—Special Bulletin No. 146 of the Agricultural Experimental Station of Michigan State College, by Roy E. Marshall, is a description of the warehouses used for the storage of apples in Michigan. A detailed account is given of the principles involved in the air-cooled storages of apples. This method is extensively employed by growers and growers' organisations with less than about 25,000 bushels of fruit for storage, as the cost of cooling the rooms by mechanical refrigeration in such cases becomes excessive. The construction and insulation of the storage houses is discussed in detail. Especial attention has to be paid to ventilation, for upon this depends the cooling, the regulation of the humidity, and the removal of deleterious gases given off by the fruits. The method adopted is to take air in through several openings or air intakes built in the walls just above the ground level or near the floor of the structure, and provide outlets through ventilators which extend from the ceiling of the fruit room out through the roof of the building. Both inlet and outlet flues are equipped with tight doors which serve as dampers to permit either the entrance of, or to exclude, the outdoor air. When the outdoor air temperature is lower than that in the storage room or of the fruit, the air inlet doors and those of the outlet flues may be opened, permitting the warmer air of the storage room to pass out through the flues. All openings are tightly closed whenever outdoor temperature is higher than that inside the room. It is stated that the most satisfactory humidity conditions are obtained with earth or clay floors to the stores. A relative humidity of 85 per cent. is recommended. To increase the humidity the floors are wetted, and to decrease the humidity the room is ventilated with colder air.

SHOT-FIRING IN MINES.—Scientific research is very often in the nature of a gamble. The capable professional researcher is sometimes much more interested in some private research than he is in his routine work. This does not mean that he neglects his routine work. On the contrary, he may do it remarkably well, but he does not devote to it labour outside his official hours. The prizes obtainable by success in private research are of far greater value than those obtainable by successful research on lines laid down by a committee. It is therefore politic from every point of view that successful team research should be encouraged. Such a research is recorded in Paper No. 11 of the Safety in Mines Research Board (London: H.M. Stationery Office, 1925, 1s. net). This paper describes a valuable research on "Electrical Exploders for Shot-Firing in Coal Mines." The means generally employed for detonating an explosive are the electric detonator and the magneto-exploder. In this research not only the minimum currents required to ignite detonators and to ignite fire damp are investigated, but also novel means are suggested for generating currents which will lie between these limits. It is found, for example, that if a broad band of copper of suitable thickness be wrapped round the armature core of a high voltage magneto-exploder, before winding, the machine can be made inherently

safe. Machines constructed in this way have proved entirely satisfactory. The designs of existing machines are criticised, and improved designs are suggested. In particular the advantages of using a small rotating magnet of cobalt steel and a stationary armature winding are pointed out. The possible use of modern dry batteries for shot-firing is considered. A battery of eight dry cells weighing only a few ounces would have a life of about three months when used for low voltage fuse-head ignition. A new form of exploder consisting of a single winding and a single dry battery is described and has been found to be safe and satisfactory in everyday use with high voltage fuse-heads. The experimenters and the sub-committee have to be congratulated on the results of their labours.

OXIDES OF BARIUM.—An account of a new peroxide of barium by M. Carlton is contained in the *Journal of the Chemical Society* for October. It is prepared by the action of an excess of hydrogen peroxide on barium hydroxide solution cooled below 20° C. The product is an unstable cream-coloured powder, which has vigorous oxidising properties. The peroxide was analysed by heating in nitrogen, passing the oxygen liberated over weighed heated copper, and weighing the residue as barium dioxide. When carbon dioxide was used the residue consisted of barium carbonate. Wet analysis was carried out with acid potassium permanganate solution. The results of analysis indicated the formula BaO_3 .

LATENT HEAT OF OXYGEN-NITROGEN MIXTURES—Experiments on the latent heat of vaporisation of liquid oxygen-nitrogen mixtures are described in the *Proceedings of the American Academy of Arts and Sciences*, vol. 60, No. 4, October 1925, by L. I. Dana. A definition of the latent heat of vaporisation of mixtures is adopted which corresponds with the production of vapour of the same composition as the liquid. A special apparatus, with electrical heating, was used. The results are tabulated, and a curve is drawn showing the latent heats from pure nitrogen to pure oxygen, mixtures being intermediate between these limits. The latent heat of evaporation of liquid oxygen (1 atm.) was found to be 51.01 gm. cal. (15°), that of liquid nitrogen 47.74 gm. cal. There is a maximum on the curve at 51.23 gm. cal. corresponding with 80 per cent. oxygen in the mixture.

ELECTRO-DEPOSITION OF CHROMIUM—At the Royal Society soirée last May, much attention was attracted by an exhibit of chromium plated objects by the Metropolitan Vickers Company. We learn from a paragraph in "Science Notes" in the December issue of the *Forum* that the Westinghouse Company of America has now been exhibiting many applications of this metal. The electro-deposition of chromium is accompanied by great difficulties, and although it is a simple matter to obtain a deposit, yet the practical production of smooth and uniform deposits has only been achieved in a very few instances. The surface when produced under the best conditions is very bright and silvery, although with a bluish tinge. It is remarkable for its resistance to tarnishing agents even in very impure atmospheres. The Westinghouse Company is using a thin deposit of chromium on the reflectors for automobile headlights. Recent experiments described in a paper to Section B (Chemistry) of the British Association show that the resistance of chromium to attack by sea-water or by spray is very high, a fact which was not at first expected, as it is known that the metal is easily attacked by hydrochloric acid. It appears that most of the difficulties in the production of smooth chromium deposits can be overcome. The great hardness of the metal, in addition to its superior power of resisting corrosion, gives it advantages over nickel.

The Oudtshoorn Meeting of the South African Association for the Advancement of Science.

THE twenty-third annual meeting of the South African Association for the Advancement of Science was held at Oudtshoorn on July 6-11, 1925, under the presidency of the Right Hon General J. C. Smuts. The meeting was well attended, eighty papers were read, and there was a number of exhibits. Joint meetings of sections were held for Prof. C. G. S. de Villiers' demonstration of Rudolf Martin's anthropometrical instrumentarium and for Prof. H. B. Fantham's paper on "Some Factors in Eugenics, together with Notes on some South African Cases." After the conclusion of his presidential address, Gen. Smuts presented the South Africa Medal and grant to Dr. R. B. Young, professor of geology in the University of the Witwatersrand. A popular lecture on "Fossilised South Africans" was given by Prof. R. A. Dart, and a public lecture on "Thomas Henry Huxley, his Life and Work" (in honour of the centenary of Huxley's birth) was delivered by Dr. Annie Porter. There was a reception by the Mayor and Mayoress of Oudtshoorn and visits to various places of scientific interest in the neighbourhood.

The president of the Association, General J. C. Smuts, gave as his presidential address, "South Africa in Science" (see *NATURE*, August 15, p. 245). He pointed out the desirability of a South African, as opposed to a European, point of view in science. Using the Wegener hypothesis of continental drift and Darwin's hypothesis of a southern and not northern origin of the fauna and flora of Africa, the relations of South Africa with other southern land masses were traced, its affinities being rather with South America, India, and Australia than with the northern hemisphere. The peculiar Cape flora appears to be rather a survival of the great flora of a southern hemisphere than the remnants of one of northern origin. The geology of South Africa is paralleled, both now and in Mesozoic times, with that of South America. The same applies to zoology. In palæontology there is more need for comparative study. Meteorology and climatology were considered, and the need for an Antarctic meteorological station for South America, South Africa, and Australia was indicated. The address concluded with a plea for the encouragement and Government recognition of research.

The presidential address to Section A was delivered by Mr. R. J. van Reenen on "Development of Irrigation in the Union of South Africa." The development of various phases of irrigation, irrigation legislation, and the institution of irrigation districts were considered. The rôle of the State in relation to irrigated land settlement was discussed, and it was urged that the State should settle irrigable land and privately owned land in excess of the owner's ability to cultivate. State loans, the growth of capital invested in irrigation, and the need for providing settlers were mentioned. Further necessary developments were noted, such as improved marketing facilities, encouragement of co-operation, and provision of factories for utilising raw products. The need of systematised water storage and its value to the stock farmer was emphasised, and a plea for more economic use of water generally was advanced.

"Soil Formation and Classification" was the subject of Dr. B. de C. Marchand's presidential address to Section B. The origin, properties, composition, and distribution of soils were discussed. The rôle of hydrolysis in soil formation was indicated. The degree of reaction, fate of the products, admixture and influence of organic matter, residue of plant growth, all determine the nature of soil. Climate as the deter-

minant of the rate and nature of mineral decomposition, and the transference of substances from one layer to another, were discussed, and also the effect of arid and high rainfall conditions. Climatic soil types in the Transvaal and the influence of climate and rainfall there on soil formation, where the soils are largely endodynamomorphic, were fully treated. The general tendency is to the formation of lateritic types of soil. One important European soil-forming factor, earthworms, is absent from the Transvaal. The fundamental classification of soils of the country is an essential preliminary to a systematic agricultural survey.

The president of Section C, Mr. E. Parish, dealt with "Problems in Agriculture in South Africa," more from the point of view of scientific agriculture than agricultural science. The adoption of mixed farming was advocated as of primary importance, the present system of crop production being compared with what occurred in the United States when land was plentiful and soil depletion and spoliation ensued. Conservation in South Africa is essential. Farming can be intensified by increasing production per unit of labour and by the supply of agricultural machinery at lower rates. Farming under irrigation was considered and the need of suitable crops in irrigated areas indicated. Technical education is a necessity for farmers, and specialised technical training is required for different sections of farming. Provision for agricultural research, freed from routine and administrative work, was urged.

Prof. J. E. Duerden, president of Section D, took as his subject, "Genetics and Eugenics in South Africa: Heredity and Environment." The special problems of South Africa in relation to heredity and environment in connexion with human beings and domestic stock were outlined. Hereditary constitution and environmental influences are both important, and change in one affects the other. In agricultural stock, blood improvement is going on, but better conditions of maintenance are necessary. Variations in parts of ostrich plumes and merino wool show the diversity resulting from differences in nutrition, though from the same germ plasm. The limitations of germ plasm and environment were discussed. The interactions of the white race and the Bantu were considered; "indigent" whites were regarded as products of unfavourable environment and the presence of the primitive native. The rôle of the white races in South Africa was considered to be that of a benevolent aristocracy of ability. The extreme importance of genetics and eugenics to South Africa was emphasised.

"The Present Position of Anthropology in South Africa" was the presidential address to Section E, delivered by Prof. R. A. Dart, who pointed out that in South Africa every one is bound to have anthropological interests. A brief historical résumé of the discoveries at Boskop, Oldaway, Broken Hill, Zitsikama, and Taungs showed that the negroid is not the primitive South African stock. The various fields of anthropological study in South Africa were noted. Philology needs attention in view of numerous native tongues, official bilingualism, Arab, Malay, and Asiatic populations. Ethnology needs much study, as do also native music and arts. Physical anthropology deserves attention in order to obtain an understanding of the laws that govern racial divergence. The address concluded with an appeal for fostering and retaining an African and not a European outlook in regard to African problems.

Prof. H. A. Reyburn chose "Psychology and

Grammar" as the subject of his presidential address to Section F. He discussed language from the psychological point of view, showing that in grammar, confusion arises between the mechanism of the language and the function that mechanism fulfils. Accidence and syntax, considered psychologically, break down these distinctions. The definitions of some of the parts of speech were discussed and their unsatisfactory nature demonstrated. The conception of different grammatical categories, with reference more especially to the work of Jespersen, was critically examined. Language as applied logic was discounted and a plea made for the psychological study of language. A suggested scheme for the re-study and re-writing of grammar was outlined.

It is only possible to note briefly the interesting papers and exhibits given before the various sections.

In Section A, Prof. G. H. Stanley gave a paper on a method of determining the relative resistance of paving materials to wear by subjecting flat pieces of equal area of the various materials to the grinding action of horizontally rotating steel discs. Mr. R. J. van Reenen gave an account of the apparent regularity of wet and dry years in South-West Africa, a series of dry years occurring at thirty-five years' intervals, coinciding with the Brückner cycle. Dr. J. Schonken discussed effective rainfall. A paper by Mr. A. G. Hoyer dealt with star streaming and the structure of the universe.

In Section B, Dr. B. de C. Marchand and Mr. C. R. van der Merwe gave an account of the fractions separated by mechanical analysis from some Transvaal soils, the differences between the clays from the red and black soils being determined. Mr. W. Torrance described a prehnite vein in the dolerite at Grootfontein, Middelburg, C.P., due to percolating waters depositing their load in a fissure in the dolerite. Mr. G. Ingham contributed a paper on the relative availability of phosphatic fertilisers on acid and non-acid soils, this being generally low on acid soils and high on non-acid ones. A note on the banded ingredients of South African coal was given by Prof. J. A. Wilkinson. Mr. B. J. Smit and Dr. T. J. Naude gave a paper on fumigation with liquid hydrocyanic acid, and Mr. E. George presented papers on phenol 5-methyl-isatein, phenol phthalamein, phenol umbellein, and resorcinol umbellein, and on the preparation of umbelliferone.

In Section C, Dr. E. M. Robinson described the bacteria of the *Clostridium botulinum* C type and their distribution, with notes on his work on lamsiekte. Mr. J. F. V. Phillips gave an account of the ecology of *Platylophus trisohatus* as seen in the Knysna forest. Mr. L. Verwoerd described some South African Hymenogastraceæ. Prof. P. A. van der Bijl described some new South African fungi and also gave a preliminary report on the fungi of the Knysna district in his herbarium. A paper on the retardation of the ripening processes of pears at high temperatures was contributed by Dr. F. J. de Villiers, who finds that 30° C. appears to be the optimum for ripening. Mr. J. F. V. Phillips contributed a paper on plant phytometers and the use of indigenous tree seedlings in this capacity in practical forestry. Mr. A. Stead presented a note on the fructifying action of heat on the pineapple, so many as twenty small fruits have been obtained from one plant. Dr. F. J. de Villiers discussed the differential freezing of pear tissues, and Miss E. Stephens demonstrated the plants obtained by her from cultures of dried mud.

In Section D, Prof. H. B. Fantham gave an account of some more parasitic Protozoa found by him in South Africa, including herpetomonads from new molluscan hosts and flagellates from various veld

rodents that transmit plague. The interesting ciliate, *Discomorpha*, has been obtained from the intestine of a horse. Prof. E. H. Cluver gave a paper on cardiac mortality in Johannesburg and at the Coast, showing from statistics that such mortality in Johannesburg, despite its altitude, is less than at the Coast. Miss N. F. Paterson summarised her experiments on the effects of differences of hydrogen-ion concentrations on the development and longevity of certain mosquito larvæ. Prof. J. E. Duerden and Mr. V. Bosman gave an account of their biometric analysis of wool fibres, establishing the proportion of various sizes of fibres in a staple. Prof. E. Warren dealt with amitosis and fragmentation of nuclei in the development of the spider, *Palystes*, in which four types of chromosomes occur. Prof. C. G. S. de Villiers gave an account of recent researches on the breast-shoulder apparatus of certain Anura, both living and extinct. Prof. R. W. M. Mettam gave a note on the occurrence of a muscle of doubtful origin found by him in the foot of a horse. Mr. H. H. Curson notified the occurrence of *Trypanosoma vivax* in Bechuanaland, this being one of the three parasites of nagana. The histology of the lining of the stomach of the ostrich was described by Miss G. T. Brock. Prof. A. J. T. Janse described the anatomy of a gynandrous form of the butterfly, *Precis sophia*. Mr. J. F. V. Phillips gave an account of the natural history of the herd of Knysna elephant. The locust-fungus, *Empusa grylli*, and its effects on its host were described by Dr. S. H. Skaife, who finds that the epidemic among the locusts stops on the cessation of the rains. Dr. F. G. Cawston gave a note on the radulæ of some fresh water molluscs. Prof. C. G. S. de Villiers gave a demonstration of Rudolf Martin's improved instrumentarium for anthropometrical investigation. Prof. H. B. Fantham and Miss N. F. Paterson reported on their further work on the Protozoa of certain South African soils, in which the seasonal variation in the protozoal fauna of waterlogged soils, and those of waterlogged soils from mining areas were noted, as were various environmental effects. Prof. Janse gave a paper on the systematics of the Lepidoptera. Dr. Annie Porter reported that *Limnæa truncatula* serves as an additional host for *Fasciola hepatica* in South Africa.

A joint meeting of Sections C, D, E, and F was held for a paper by Prof. H. B. Fantham on "Some Factors in Eugenics, together with Notes on some South African Cases." Selective birth-rate and selective death-rate, differential birth-rate in different strata of society, and racial admixture were discussed, and notes on some cases of inheritance of certain well-marked physical and mental characteristics and of the results of racial admixture were given.

In Section E, Mr. C. van Riet Lowe gave an account of the kinds and distribution of stone implement workshops in the Orange-Free State. Mr. A. J. H. Goodwin discussed the Capsian affinities of the South African later Stone Age culture; he considers that the Smithfield and Pygmy industries in South Africa are culturally the same as the North African Capsian one. Prof. R. A. Dart described the round stone culture in South Africa. An exhibit of copies of numerous Bushman paintings from the Kei River was arranged by Brother Otto, and Prof. E. H. L. Schwarz exhibited tracings of Bushman paintings from the Clanwilliam District. Mr. J. Hewitt's paper dealt with stone implements from various sites in the Cape Province, representing different cultural developments. Prof. Dart gave a note on Makapansgat, where beds of fragments of fossilised bones, too small for identification, occur. Mr. G. D. Lang gave a further report on the Zitzikama material and described another skeletal find in an ancient Roorberg

mme-working Mrs. J. D. Laing contributed remarks on the temporo-mandibular region in the Boskop, Strandlooper, Bushman, and negro peoples. Anthropometric measurements of the skeleton of the Boskop race were given by Mr. H. S. Gear, and the brain of the Boskop race was discussed by Prof. Dart, who also exhibited casts of the Taungs skull and a Boskopoid skull obtained by Prof. M. R. Drennan from a subject in his dissecting-room at the University of Cape Town. Miss E. Dora Earthy gave a paper on the rôle of the father's sister among the Va-Lenge of Gazaland. Mrs. A. W. Hoernlé discussed the sib in Southern Bantu marriage ceremonies, showing the deep-seated nature of the relation of the sibs and their relation to lobola, which involves the contracting parties, the sibs, and the ancestral spirits. Mr. E. C. Randell described a supernumerary molar tooth in a Bantu. Mr. H. Q. F. Thompson described the custom of amputation of part of one of the fingers by the Zulu-Xosa groups of Bantu. Mr. G. D. Laing gave an initial report on somatometric investigations among the natives recruited for the Witwatersrand. Mr. C. Dawson described the Neanderthaloid foot of the Zuurberg Bushman. Father Huss and Brother Otto discussed the origin of Bushman paintings at the Kei River. Mr. I. Schapera gave a paper on stylistic affinities of Bushman art, stating the criteria for comparison of

Capsian, North African, and Bushman art. Mr. F. R. Paver traced Asiatic influence on early South-East African development from various records. Mr. S. Zuckerman gave a note on a superficial scraping of the floor of a rock shelter in the Cape Midlands.

In Section F, the normative character of ethics was discussed by Prof. G. H. T. Malan. Mr. C. Graham Botha gave a paper on the distribution of South African fauna in relation to place-names, indicating the former distribution of animals now extinct. He also described social customs in South Africa during the eighteenth century, such being influenced both by Holland and the East Indies. Prof. R. D. Nauta gave a paper on the Spanish Cid. Dr. F. G. Cawston gave notes on some removable causes of unemployment and crime. Mrs. C. G. Botha described some minor experiments in the unconscious. Dr. A. Barradas gave statistics of mortality in Lourenço Marques for the past seventy years. Mrs. Mabel Palmer traced the evolution of the organisation and technique of adult non-vocational education. Mr. C. S. Richards gave a critical paper on the Kammerer-Vissering Report and the position of the Reserve Bank, the proper function of which was outlined.

The next annual meeting of the Association will be held at Pretoria, under the presidency of Dr. E. T. Mellor, in July 1926. H. B. FANTHAM.

Transmission of Power.

AN interesting analysis of the problem of the transmission of power is contained in a paper read by Mr. G. Constantinesco before the North-East Coast Institution of Engineers and Shipbuilders on December 4. The author is well known in engineering circles as the inventor of the method of transmitting energy by "wave transmission," in which the liquid does not circulate. He formulates the following fundamental laws governing any transmission of power: (1) Energy can be transmitted from one point to another only at the expense of a definite loss. (2) There is a minimum loss in any given system or method of transmission which cannot be decreased by any conceivable improvement in the system. (3) The transport of energy is possible only by circulation or oscillation, and there is a minimum amount of matter necessary for such transport. Such minimum is also independent of present or future methods of transmission, and depends only on the amount of energy, distance of transport, and change of form of the energy.

There are three broad classes of systems of power transmission, namely, mechanical, fluid, and electric. The author takes a few random problems of power transmission and first shows that the efficiency curve for any electric system can be drawn irrespective of the particulars of the transmission considered. The curve appears as an invariant when the units of measure are taken as the minimum possible loss and the critical voltage for which this minimum loss occurs. He then gives a lengthy investigation of hydraulic transmission and shows that the whole curve of efficiency is also an invariant, and that once the maximum "peak" possible efficiency is known, the whole behaviour of the transmission can be predicted. There is a handicap to high efficiencies in fluid transmissions owing to the unavoidable loss in changing the energy abruptly from one form to another. Thus, if the energy is available at the shaft of a prime mover in the form of a rotating torque, the transformation of this into hydraulic energy is accompanied by a definite loss, which is independent of the means by which the transformation is made.

The peak efficiency of transformation depends only on fixed constants defining the fluid itself. The same conclusions are reached in the transmission of energy by use of gases.

The efficiency curves for electric, hydraulic, and gas transmissions show the same fundamental property, namely, they are invariables of very nearly the same shape.

Experimental data regarding mechanical systems are not complete, but Mr. Constantinesco thinks that the figures would not be very different from those relating to electric and hydraulic transmissions. Peak efficiencies of a very high order are found to-day only in mechanical transmissions. There is an absolute limit to the possible peak efficiency which the author is inclined to think has already been reached in some mechanical transmissions such as link motions, gear wheels, and the like. Efficiencies of the order of 95 per cent. are practical possibilities for almost any sound mechanical transmission of moderate power when carefully designed. Hydraulic and electric transmissions may be credited with 85 per cent. This small difference in peak efficiencies is sufficient to make a relatively important difference in average efficiencies. From the efficiency point of view alone, there appears to be no doubt that mechanical transmissions are superior to electric or fluid transmissions, and if the latter can replace in certain cases mechanical transmissions, it is only from the point of view of convenience.

With one single exception, in each field, electric, fluid, and mechanical, rotary power cannot be transmitted from one point to another except by periodic or intermittent impulses. The exception is when the power is transmitted through a material body rotating at uniform speed and transmitting a constant torque along its axis of rotation. A more general statement of this *postulatum* is: "Any transmission in which the output energy differs in shape from the input cannot be accomplished without the power being transformed at one stage or another into periodic impulses." The author considers that the relations which are the basis of electric current theory form the

fundamentals of a new science of applied mechanics. The application of these relations to long-distance transmissions by liquid columns and to acoustics has enabled him to duplicate practically every manifestation of electric transmissions, and led to the invention of the "wave transmission" method of transmitting energy and also to the synchronising of machine guns on aeroplanes so as to enable them to fire through the propeller.

Electric transmissions are at present in want of higher peak efficiencies in order to come up to the level of their mechanical equivalents. No doubt progress is still possible provided electrical engineers will not develop the habit of mechanical engineers of ignoring the fact that there is still plenty of work to do, both theoretical and practical, on old neglected avenues. Fluid transmissions have a fairly uphill task to overtake either electric or direct mechanical transmissions. Mechanical transmission at present seems to offer the most promising field for obtaining immediate and substantial results.

Mr Constantinesco's paper is long, and full of speculations which cannot fail to be of interest to engineers who are concerned with the many problems of power transmission.

Food and Fattening of Oysters.¹

THE material eaten by an oyster consists of minute organisms and other matter floating freely in the water, and present in the surface soil on which oysters occur. Mr R. E. Savage has studied qualitatively and quantitatively the contents of the stomachs of oysters in relation only to the organisms and material found floating near the bottom of the sea in two localities, namely, the Main Channels of the River Ore in Suffolk and the adjacent Butley Creek. These situations were chosen because there was reason to believe that oysters fattened much more readily in the Creek than in the Channels. Data were obtained by exhausting the alimentary canals of usually six oysters once a month and taking one ten-minute sample of plankton from each bed once a month for a period of 13 months. From his restricted material, the author has extracted highly interesting facts and results, but the value of the latter is diminished by the absence of continuous contributory—and not necessarily quantitative—observations on the beds. In any estuarine problem the influence of tide and time should not be ignored. The author found that the material ingested by the oysters in the localities examined consisted of 90 per cent. or more inanimate matter ("organic detritus"), and a searching volumetric and numerical analysis of the animate food is given. He also finds that the feeding period extended from July to October or November, with a short season of brisk feeding during August and September, and that in the remainder of the year little food was found. The suggestion adopted that the absence of feeding in winter may be due to the effect of low temperatures on the ciliary and muscular feeding mechanisms is well worth definite examination. There was a definite difference in the quality and quantity of the animate food in the situations chosen.

In analysing the results for these two regions, the author finds (1) that the total food consumed is approximately equal in volume, but that (2) the percentage volume (quantity) of animate food is four times as large in the Creek (where fattening occurs) as in the Channels (where fattening is less

satisfactory; the italics are ours), and that (3) the proportion of diatoms in the food of oysters from the Creek is greatly in excess of animals, while the proportion of animals in the food of Channel oysters is greater than that of diatoms. No proof is produced of better results in fattening in the Creek, where the food was mostly diatoms, and proof is unfortunately required since "fattening" is, in our present knowledge, highly capricious. The author concludes "that there is an apparent relation between consumption of diatoms and fattening," and "suggests that fattening is due to diatoms and growth to inanimate food."

The suggestion that fattening is due to diatoms (in this case mainly *Nitschiella*) is probably true for the particular locality studied, but on the author's data the difference in quantity of animate food might equally well account for a difference between "fattening" and "less satisfactory fattening." The reviewer holds the view that the problem of fattening will not be solved by a mere consideration of food. Fattening is chiefly a storing up of the surplus products of metabolism—mainly as glycogen—presumably for general purposes, but is also in part due to proliferation of the sex-organ. Hence the whole activities of the living animal, namely, growth, breeding, environmental conditions, as well as feeding, must be considered. A simple illustration will prove this: oysters which have recently grown a great deal of shell (and have been actively breeding) have mostly poor "fishes," i.e. are not fattened, whereas poorly grown dumpy or semi-dumpy oysters, taken in nearly equal proportions in the same hauls of the dredges as the well-grown ones, have large plump fishes, that is, are very well fattened, as the following figures,² which have been confirmed in larger numbers, will show.

Thirty-one oysters of average size 66 mm. x 67 mm. and average new growth 20 mm. had an average "fish" weight of 5.3 grams, whereas dumpy oysters ranging to a maximum size of 53 mm. x 68 mm. and with an average growth of 6 mm. had an average fish weight of 7.5 grams. Larger oysters 83 mm. x 81 mm. with average new growth 29 mm. had average fish weight 9.7 grams, but a typical large dumpy oyster 68 mm. x 75 mm. with 5 mm. new growth had a fish-weight of 13.5 grams.

J. H. O.

¹ Taken from Report on a Survey of the Oyster Beds in the Estuary of the Fal with Notes on the Biology of the Oyster, p. 91, January 1925. See also NATURE September 26, p. 486, where a review of the Summary published for the Falmouth and Truro Corporations was noticed.

Voltaire and Medicine.

IN the first part of a paper on "Voltaire and Medicine" read before the section of the History of Medicine of the Royal Society of Medicine on October 21, the president, Dr. J. D. Rolleston, quoted the words of the celebrated Berlin physiologist Prof. Emil Du Bois-Reymond, who in an address on Voltaire in his relation to natural science, attributed the neglect of this philosopher in the nineteenth century to the apparently paradoxical fact that we were all in a sense Voltairians without knowing it. "The ideals of tolerance, mental freedom, dignity and justice for which Voltaire had fought . . . had become a natural element of life like the air we breathe, which we only notice when we are deprived of it." Dr. Rolleston's paper dealt with Voltaire's relations to individual doctors and the medical profession as a whole, including some account of Voltaire's various illnesses. He contracted a severe attack of small-pox at the age of twenty-nine years, but apart from influenza and pneumonia he does not appear to have had any other

¹ Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 8, No. 1, 1925. The Food of the Oyster. By R. E. Savage. Pp. 50+3 plates (London: H.M. Stationery Office, 1925) 8s net.

acute infectious disease. He was subject to chronic dyspepsia from an early age, and frequently suffered from catarrhal bronchitis, often associated with deafness and aphonia. He frequently complained of febrile attacks which may have been malarial in origin. His death at the age of eighty-four years was probably due to uræmia following cystitis secondary to enlargement of the prostate which was found on post-mortem examination.

Voltaire was brought into contact with medical men on numerous occasions, both professionally and socially. During his stay in London (1726-29) he appears to have been acquainted with several leading medical men of the time, especially Sir Hans Sloane, Mead and Freind, as well as with other medical fellows of the Royal Society, especially Arbuthnot and Pemberton. He was himself elected F.R.S. in 1743. Among the numerous doctors whom Voltaire consulted the best known are Silva, physician to Louis XIV.; Boerhaave, whose name frequently occurs in Voltaire's works, especially in connexion with chemistry; and Tronchin, whom he described as the greatest physician in Europe and the only one who understood Nature.

Voltaire's works, particularly his correspondence, the "Dictionnaire Philosophique," his tales, and to a less extent his historical works, miscellaneous essays and pamphlets, abound with references to the medical profession. Many allusions are to be found to the masters of medicine, such as Hippocrates, Rhazes, Servetus, Harvey and Sydenham, as well as to celebrated anatomists such as Vesalius, Ruysch, Bartholin and Vieussens, but the medical works with which Voltaire was most familiar was probably that of Astruc on the venereal disease. The passages in which he indulges his satirical humour at the expense of the profession are few and unimportant in comparison with those in which he expresses his admiration and gratitude, and apart from the tales are chiefly to be found in his correspondence, where they are probably not to be taken too seriously. On the other hand, Voltaire was scathing in his denunciation of quacks, and vented his ridicule on many superstitions and erroneous doctrines connected with normal and morbid processes, particularly spontaneous generation, which was upheld by Needham and combated by Spallanzani.

University and Educational Intelligence.

GLASGOW.—The University Court on Thursday, December 10, appointed to the chair of natural philosophy Dr. Edward Taylor Jones, professor of physics in the University College of North Wales, Bangor. In 1899 he succeeded Prof. Andrew Gray in the latter chair; and now succeeds him in Glasgow also. A distinguished pupil of Prof. Gray at Bangor, he graduated with the highest honours in the University of London. With the aid of an "1851 Exhibition" research scholarship, he proceeded to the University of Berlin, where he worked under Profs. Kundt, du Bois, Rubens, von Helmholtz, Planck, and Fuchs. His important memoir on "Electromagnetic Stress" procured him his doctorate. Returning to Bangor in 1896 he was appointed lecturer, and afterwards professor of physics. He has also held in succession the administrative posts of Dean and Chairman of the Faculty of Science, representative of the Senate on the Council, member of the University Court of the University of Wales, and Vice-Principal of the College. Prof. Taylor Jones has published some thirty papers on electrical subjects, in particular on electrical oscillations, coupled circuits, the singing electric arc, and the triode valve generator, all having

important bearings on wireless telegraphy and telephony. He is recognised as having placed the theory of the induction-coil on a sure basis, and his book on that subject is the standard treatise. He also co-operated with the Internal Combustion Engine Subcommittee of the Advisory Committee for Aeronautics. He will take up his duties in Glasgow at the beginning of next term. He is fifty-two years of age.

LIVERPOOL.—Miss Winifred E. Frost has been appointed to the Herdman Memorial Scholarship for 1925.

Dr. T. P. Hilditch has been appointed to the Campbell Brown chair of industrial chemistry. The appointment is in the first instance with special reference to research on oils, fats, and waxes. Prof. S. H. Gaiger, of the Veterinary College, Edinburgh, has been appointed to the William Prescott chair of the care of animals with special reference to the causation and prevention of disease.

In a lecture delivered on December 4, Prof. G. H. Henderson, of the University of Glasgow, advocated that chemists should endeavour to educate the public to the value of their profession to the community and its importance in national welfare. He would like to see a unified body controlling all chemists and speaking for the profession as a whole.

MANCHESTER.—Prof. A. H. Gibson has been elected Dean of the Faculty of Science. The following appointments have been made:—Dr. J. C. Smith to be assistant lecturer in chemistry; and Mr. J. C. Brierley to be assistant lecturer in engineering drawing (Faculty of Technology). Dr. E. N. Mottram has been awarded the Sir Clements Royd Memorial Scholarship in chemistry.

PROGRAMMES have now been issued of the annual meetings of the Science Masters' Association and of the Association of Women Science Teachers. The Science Masters' Association meets at King's College for Women, London, on January 5-7, under the presidency of the Right Rev. C. W. Barnes, Lord Bishop of Birmingham. The presidential address will be delivered on the first evening of the gathering, and the general programme includes lectures by Dr. T. Slater Price on "The Sensitivity of the Photographic Plate," and by Prof. Leonard Hill on "Sunshine, Open Air, and Health," and discussions on "Science and Citizenship," to be opened by Mr. W. D. Eggar and Mr. O. H. Latter, and on school science examinations, to be opened by Mr. D. J. Berridge, Mr. E. Nightingale and Mr. E. G. Laws. Invitations have been accepted for parties to visit the laboratories of the General Electric Company and also the National Physical Laboratory, while there will be the usual exhibition of apparatus and books by members of the Association and by publishers and instrument-makers. The annual general meeting of the Association of Women Science Teachers will be held on February 6 at St. Paul's Girls' School, London. The programme includes a demonstration by the Visual Education Society of educational films and an address by Miss Coward on the teaching of hygiene in schools. Miss Bond is to move a resolution "that in view of the fact that for the majority of pupils the General School Examination (School Certificate) terminates their study of Botany, it is desirable that the Syllabus in Botany be amended as follows: (1) The number of Families should be very much reduced, and the ability to use a Flora should take the place of most of this detailed knowledge. (2) The life histories of, at least, one Alga and a Fern should be included in the Syllabus. These should be simply treated so as to need only a small amount of microscopic work."

Early Science at Oxford.

December 21, 1683. Mr. Ballard was desir'd to try some experiments, in ye Holy daies, in order to the solution of the question: Whether cast-Iron will draw ye needle, as readily as that which is forg'd? Dr. Smith was pleased to shew us some observations, which he made in his voyage to Constantinople, año 1668; when among other things, ye Dr. observed a great number of Porcpisces, which almost covered a good part of ye Propontis, from ye Seraglio point, towards ye Islands, that lye over against the bay of Nicomedia; for which reason (as also because he never heard that any Dolphins are caught there by ye Greeks, the good fishermen; nor saw any sold in their Markets) He thinkes, that Solinus, cap 12, is to be understood of Porcpisces, not of Dolphins; although he says (speaking of ye Bosphorus, and Hellespont) hæc profunda *Delphinus* plurimos habent. As for that vast quantity of water, which runs into ye Mediterranean, he conjectures that a great part of it may run out again, by an under-current, at ye Strait's mouth.

Wee then examin'd ye effects of a distillation of brine, from salt of Tartar, which Mr. Ballard at ye request of ye Company had performed; The brine was made of a pint of common water, and $\frac{3}{4}$ of white salt, which, after sufficient heating, was distill'd from Salis Tart: $\frac{3}{4}$: we saw about $\frac{1}{2}$ lb. of ye distilled water; it was not in ye least brackish, but rather like an emulsion of sweet almonds.

1686. A Letter from Dr. Bagley to Mr. Musgrave was read: it gave an account of the dissection of ye *Hedghog*, male and female.

An account of a *horn* growing on the head of one Mary Davies of Soughal, of Wyrehall Hundred in Cheshire, aged 71. in 1668. The compasse of the horn at the root was 3 inches and more than half; the length of the horn layd out straight 5 inches and a half. An account of the Duke of Tuscany's *Diamond*, which weighs 138 carats.—An account given by Dr. Plot of *ale* made with *Walnut leaves* instead of Hops in Staffordshire: there being great scarcity of these, last Summer; he says 'twas pleasant and kept very well.

The Society resolved that *Aristarchus* be printed in Greek and Latin at ye charge of this Society; Dr. Plot having promised to provide paper, and Mr. Deeds to collate the MSS.

A resolution of a question of compound *Interest*, at one operation of Logarithms, likewise a solution of this problem viz. from the different weights of the same heavey body in different fluids.

December 23, 1684. Mr. Musgrave acquainted ye Society concerning ye colour of ye liquor conveyed by ye Lacteals. In this letter he endeavors to prove, that a great part of ye Chyle passes *pellucid* through ye Lacteals, (contrary to ye opinion of those, who thought it to be *always white* in those vessells); and that a pellucid Liquor *Refluus* does constantly fill some of them, when no flash of Chyle can be supposed to extend them. He then read Dr. Lister's answer to this Letter; The Dr. is willing to think that the *liquor Refluus* may be of ye nature of *Lympha* but he takes ye greatest part of what fills the Lacteals in sicklie and empty animals to be Pituita, and sometimes Bilis.

Mention was made of a proposall of Dr. Lister's, which was to try Kunckel's experiment [of coagulating milk, by adding spirit of wine to it,] both with a spirit, drawn from pure Nants-Brandy, and also with a spirit drawn from an eager wine: it being possible, as ye Doctor thinks, that ye experiment may succeed with ye one of them, and not with ye other.

Societies and Academies.

LONDON.

Faraday Society, November 16.—E. D. Campbell: A study of the correlation of the permanent magnetism and specific resistance of some pure iron-carbon alloys.—J. A. V. Butler: Co-ordination and co-valency. The formation of co-ordinated complexes cannot be due in general to the tendency of the central atom to attain the configuration of the next higher inert gas. The electrons contributed by co-ordinated groups form a distinct group round the central ion. A distinction is drawn between (a) *Co-valency*: the mutual sharing of electrons by two atoms so as to complete already existent groups, therefore involving negative valences, and (b) *Co-ordination*: the formation of a new group of electrons outside the last group represented in the ion. It is proposed to use the specific term *co-ordination valency* for the number of co-ordinated groups. It is assumed that the co-ordination electrons enter the main "quantum group" next to that represented in the central ion.—J. R. Partington and N. L. Anflogoff: An improved form of electric vacuum furnace. A vacuum furnace of the Ruff type was used for studying reactions at high temperatures. The reacting substances, if solids, are contained in a graphite crucible turned from the same material as the hot tube and maintainable either in a high vacuum or in an atmosphere of an inert or reacting gas. The issuing gas is capable of analysis.—J. R. H. Coutts and E. M. Crowther: A source of error in the mechanical analysis of sediments by continuous weighing. The low density of suspension immediately below the balance pan after the sedimentation has proceeded for a few minutes inevitably sets up a flow of liquid which interferes with the free vertical fall of the particles. With the large narrow-rimmed pans hitherto used, the observed yields are appreciably below the theoretical values. With the pan close to the base there is a very rapid change of yield with very small changes in the position of the pan.—Donovan Werner: A simple method of obtaining the size distribution of particles in soils and precipitates. The method has been developed in researches on the reaction mechanism during the formation of precipitates. It has been necessary to know the total surface of a precipitate as a function of time while the precipitate is forming. At first the particles can be measured by an ocular micrometer, but just as the particles become larger and more irregular in size during the precipitating process, at the same time forming aggregates, it becomes correspondingly difficult to get values sufficiently exact. The measuring of the velocity of the sedimentation gives an "accumulation curve," and from this curve the size distribution can be calculated according to the mathematical theory developed by Odén.—F. G. Tryhorn and W. F. Wyatt: Adsorption by coco-nut charcoal from alcohol-benzene and acetone-benzene mixtures. Adsorption isotherms for each component of such mixtures have been determined at 20°. By an analogous method, measurements have been made of the composition of the vapours in equilibrium with mixtures of the above liquids at 20°. A comparison of the results of adsorption by charcoal from the liquid and the vapour phases supports the conclusion that an adsorbed film in equilibrium with a saturated vapour must be also in equilibrium with the liquid in contact with that vapour. Alcohol is selectively adsorbed from all mixtures of alcohol and benzene. From acetone-benzene mixtures, acetone is selectively adsorbed from mixtures containing up to 72 molar percentage

of acetone in the vapour phase. Above that value benzene is selectively adsorbed to a slight extent.—F. L. Usher: The nature of the interfacial layer between an aqueous and a non-aqueous phase. Experiments were undertaken to obtain information on the question whether the ions bearing a charge of opposite sign to that of the non-aqueous phase are movable only as a complete layer, or whether some or all of them are independent; and secondly, on the extent to which the observed behaviour of aqueous suspensions is in agreement with the consequences deduced from the answer to the former question. They deal (1) with the determination of the total charge on the particles of a suspension by neutralising it with a measured quantity of ions bearing a charge of opposite sign, and (2) with the effect of electrolytes in modifying the surface charge.

Geological Society, November 18.—W. L. F. Nuttall: A revision of the Orbitoides of Christmas Island (Indian Ocean). A complete revision has been made of Jones's and Chapman's species. Six species of *Lepidocyclus*, one species of *Miogypsina*, and one of *Spirocyclus* were identified. The lepidocyclines possess no pillars in the lateral chamber-layer, and the two megalospheric forms have the embracing type of primordial chamber restricted to the subgenus *Eulepidina*. These species are found in Limestone C, as defined in the Christmas Island monograph (British Museum, 1900), which is classified as Lower Miocene. A *Discocyclus* has been found in Limestone B as well as in A, no orbitoides having been hitherto discovered in the former. This indicates that these beds are both of Eocene age.—W. Campbell Smith: The volcanic rocks of Christmas Island (Indian Ocean), with chemical analyses by E. D. Mountain. There were two periods of vulcanicity in Christmas Island. The older lavas are overlain by a limestone now proved by Mr. W. L. F. Nuttall to be Eocene. These upper lavas are overlain by a limestone with Orbitoides referred by Mr. Nuttall to the "older Miocene" of Rutten. All the lavas, both Eocene and Miocene, are considered to belong to a single petrological series. The rocks resemble very closely certain Tertiary and Permo-Carboniferous lavas from New South Wales. On the other hand, no analyses of rocks from Java and Sumatra are found to compare with those of the Christmas Island rocks.

Linnean Society, December 3.—F. J. Lewis: Preliminary account of a fungus in the tissues of Coniferæ. The results refer particularly to *Picea canadensis*, which has been collected from many habitats and varying in age from small seedlings to trees more than two hundred years old. The cortex of the youngest rootlets is penetrated in every direction by fine hyphæ, which not only enter the living cells, but grow through the middle lamellæ of the walls. They also penetrate the endodermal cells, and in some cases almost fill the lumen. Older rootlets from which the primary cortex has been cast off show the cells of the broad pericycle filled with fine branched hyphæ. In the unopened bud the fungus is localised in certain enlarged cells irregularly distributed above the crown near the base of the embryonic leaves. As the meristematic cone bearing the embryonic leaves elongates, the fungus spreads upwards from the region of the crown forming a network of infested cells.—Papers on the collections made during the expedition of H.M.S. *Sealark*.—Hugh Scott: The Ciidæ (Coleoptera) of the Seychelles. Ciidæ are small or minute beetles, usually of almost cylindrical shape, which are found boring in fungi, often in very large numbers. The present report enumerates 20 species, 18 of which were found in the Seychelles proper,

while one was found both in the Seychelles and Aldabra, and one in Aldabra only. Taking the Seychelles species as a whole, more than half were found exclusively in the endemic forests at high elevations, and these insects are probably endemic; among the few species taken in cultivated places are the only forms (three in number) known to occur outside the islands.—D. J. Matthews: Physical oceanography of the Indian Ocean. A well-marked discontinuity layer occurs at nearly all the serial positions, and its presence appears to be independent of whether the station lies in the south equatorial current or not. At one position the current impinging on the bank north of the Farquhar Group at about 800 fathoms causes mixing at all depths, which lowers the temperature near the surface and increases it on the bottom by one degree Centigrade. The surface salinities are intimately connected with the currents and winds. The low salinity water which lies across the eastern entrance to the Gulf of Aden is present at all times, and is partly due to the current northwards along the east coast of Africa.—S. T. Burfield and E. J. W. Harvey: Four genera of Chætognatha were found. Of *Sagitta*, which contains 22 or 23 species generally considered valid, 14 species are represented. Of the 32 valid species of the phylum, 18 occur. The limitation of the number of species in the group is thus amply confirmed by this large collection.—C. J. van der Horst: The collections contain 18 species of the Eupsammidae.—R. Douglas Laurie: Anomura from the West Indian Ocean. The Anomura were taken from localities between 3° and 21° S. Lat., and between 51° and 73° E. Long. They comprise 48 species distributed among the tribes Hippidae (1), Galatheidae (24), and Paguridae (23). The collection presents a typical Indo-Pacific faunas. A fair proportion of the species are, however, now recorded for the first time from localities so far west in the Indo-Pacific Ocean. The three species of the present collection which reach the western coast of America, namely, *Petrolisthes lamarcki* (Leach), the deep-sea form *Parapagurus pilosimanus* Smith, and the land form *Cænobita rugosus* H. M. Edw., are three of the four which spread also to the Atlantic.—H. Britten: Coleoptera, Ptiliidae of the Seychelles. The Ptiliidae (or Trichopterygidae) are the smallest of all beetles, and the various species found in the Seychelles range in length from 0.5 to 0.9 mm. Thirteen species are enumerated from these islands.

PARIS.

Academy of Sciences, November 9.—J. Costantin: An experiment with mountain-grown potatoes. It appeared probable that seed potatoes grown in the mountains and sown in the plains would be more proof against disease than ordinary potatoes. Some experiments made in 1925, although perhaps on too small a scale, confirmed this view.—Charles Richet, Oxner, and J. Richard: Raw meat and cooked meat diet for fish. Experiments showing that for fish as for mammals, cooking meat diminishes its nutritive value.—Léon Guillet: The influence of deformations on the transformations of certain light aluminium alloys. Study of the changes brought about in duralumin and in aluminium-copper-manganese alloy by wire drawing.—de Sparre: Calculation of the maximum ram stroke in a pipe feeding a turbine with strong reaction for a constant velocity of closing.—Jean Tilho: The probable area of the maximum extension of the Aleutian sea.—J. Schokalsky: An oceanographic expedition to the Black Sea. Observations were made during 1924 and 1925 at 72 stations, the data obtained including depth, specimens taken on the sea floor, and determinations

of temperature, salinity, density, dissolved oxygen, sulphuretted hydrogen, hydrogen ion concentration, colour and transparency, as well as biological observations. The Black Sea can be considered as being divided into two layers, a superficial one of 200 metres containing water diluted by the inflow of numerous rivers, whilst from 200 metres to 2000 metres, the whole mass of water has a higher salinity and density than the upper portion.—Guntner: A lemma of M. Poincaré.—Mandelbrojt: Remark on the mode of generation of functional isogenes.—Const. Parvulesco: The dynamics of spiral nebulae.—B. Nikitine: The distribution of the plankton of the Black Sea. The lower limit of appearance of the plankton is 200 to 225 metres. The principal influence on the vertical distribution of zooplankton is the temperature. In the case of the phytoplankton, besides the temperature there are the effects of variations in the quantities of inorganic nitrogen, phosphates, and silicates.—Paul Pascal: The magneto chemistry of closed chains. The experimental values for the molecular magnetic susceptibility for eight types of homocyclic and heterocyclic chains are compared with the figures calculated from the ordinary rules of additivity. In the polymethylene rings, the effect of non-saturation varies with the number of carbon atoms in the ring and is zero for the pentamethylene series. It is pointed out that the reductions in the molecular diamagnetism are in agreement with the predictions of Baeyer's strain theory.—E. Jouguet: Waves of shock and irreversible residual combustion.—J. Cournot and K. Sasagawa: The viscosity of some alloys at high temperatures.—H. Perpéro: The action of gaseous ammonia upon phosphorus chlorides. An attempt to prove that the primary action of ammonia upon the chloride PCl_5 is $\text{P}(\text{NH}_3)_3$.—V. Auger and T. Karantassis: Complex salts of stannous iodide with the iodides of rubidium and caesium. Preparation and analyses of the compounds RbSnI_3 , RbSn_2I_5 , CsSnI_3 , and CsSn_2I_5 .—B. Bogitch: The refining of mattes. The action of sodium sulphate.—A. Mailhe: A new method of bleaching petrols produced by cracking or by catalysis. Yellow petrols containing unsaturated hydrocarbons can be refined by digestion at the boiling point with stannous chloride.—Er. Toporescu: The cracking of ozokerite. Details of cracking experiments in which anhydrous aluminium chloride was used as a catalyst.—Albert Kirmann: The action of metallic sodium on bromoethylene derivatives. The bromoethylenes $\text{R} \cdot \text{CH} : \text{CHBr}$ and $\text{R} \cdot \text{CBr} : \text{CH}_2$ react with sodium giving the hydrocarbon $\text{R} \cdot \text{CH} : \text{CH}_2$, the acetylene derivative $\text{R} \cdot \text{C} \cdot \text{CH}$, and small quantities of higher boiling point condensation products. The yields of the various types of hydrocarbon do not admit of a simple theoretical explanation.—A. Demolon: The clay material of the quaternary muds.—A. Demay: Two new forms of quartz in petrosiliceous porphyrys; lamellar quartz and spherulites with granular quartz.—P. Lejay: Storm disturbances of the electric field and their propagation at a great distance.—Jean Piveteau: The signification of the sternum of the vertebrates. From three examples studied (*Feylinia*, *Sphenodon*, *Tangasaurus*) it is concluded that it is not possible to consider the sternum as a morphological entity, and that it can only be defined from a physiological point of view.—R. Anthony: A brain of the foetus of *Megaptera boops*.—Raymond Poisson: Some observations on *Anisops producta*. The adult *Anisops* may prove to be a useful auxiliary in the battle against *Anopheles*.—Emile F. Terroine, R. Bonnet, and A. Hée: The energy yield in the development of various plant organisms as a function of the amount of oxygen in the surrounding medium.—Henri Piéron: Is the Bunsen-Roscoe law applicable

to the luminous stimulation of the invertebrates? Experiments made on the effect of light on *Mya* (movement of retraction of the siphons) proved that the Bunsen-Roscoe law does not hold.—Robert Lévy: The hæmolytic properties of the pedicellar processes of certain urchins.—Mme. Anna Drzewina and Georges Bohn: The acidification of the medium by cellular cytolysis.

ROME.

Royal Academy of the Lincei, Communications received during the vacation, 1925.—F. Zambonini and R. G. Levi: Investigations on the isomorphism of the molybdates of the rare earth metals with those of calcium, strontium, barium, and lead.—Mineo Chini: Determination of the isogonal trajectories of a system of lines in certain surfaces.—Bruno Finzi: Considerations on the irrational motions of liquid laminae.—E. Raimondi: Dynamic effect of a current flowing between a plate and an indefinite plane wall.—U. Crudeli: Method of resolving a fundamental problem in the theory of the stationary slow motion of viscous liquids.—Rita Brunetti: Continuous absorption along an optical series and the structure of the discontinuity of absorption at high frequency.—V. Ronchi: Measurement of double stars with a grating interferometer.—G. Bargellini: α -Phenyl- β -methylcoumarins. Descriptions are given of a series of products obtained by condensing various ortho-hydroxy-substituted acetophenones with sodium phenylacetate and acetic anhydride.—Remo de Fazi: Syntheses in organic chemistry by means of radiant energy. (i.) Photosynthesis of $\alpha\beta$ -triphenyllactic acid. This acid is formed by the addition of a molecule of benzophenone to one of phenylacetic acid under the influence of light.—G. Scagliarini and E. Brasi: Additive compounds of tin and titanium halides with organic bases.—G. Checchia-Rispoli: Vertical diffusion of *Orbitoides s str*—Tullio Carpanese: The epidote of Monte Rosso di Verra (Monte Rosa group)—A. Clementi: The osmotic pressure of the hæmo-lymph and tissues of *Helix A.* during lethargy.—Giuseppe Russo: The curve of development of a xylophagous coleoptera, *Chaetopelmus vestitus*.

VIENNA.

Academy of Sciences, October 22.—Papers on electrolytic conductivity in molten metal alloys.—XI. R. Kremann, H. Krieghammer and P. G. Rehenburg: Na-Hg alloys of various composition.—XII. R. Kremann, H. Krieghammer and A. Trostek: Bismuth-tin alloys.—XIII. R. Kremann and O. Baukovac: Tin-cadmium alloys.—XIV. R. Kremann and J. Dellacher: Attempts at electrolysis of alloys of aluminium with magnesium, antimony, zinc and silver.—XV. R. Kremann and O. Baukovac: Attempted electrolysis of metallic sulphides and of phosphides.—XVI. R. Kremann and K. Bayer: Electrolysis of alloys of silver with Sn, Sb, Bi and Pb.—E. Steinach, H. Heinlein and B. P. Wiesner: Release of the sexual cycle, development of sex characters, rejuvenating effect on the senile organism of extracts of ovary and placenta. Experiments on rats and guinea-pigs. In the last two years experiments have been carried out with extracts of gonads and other organs, and in testing the effect of these extracts the criteria chosen have been the development of sexual characteristics in animals castrated in infancy, the rejuvenating effect on senile females and also the release of the sexual cycle. A stable substance has been obtained from the ovary and from the placenta which on injection produces these effects.—A. Smekal: On the constitution of the mono-crystalline state of aggregation. The ideal crystal lattice

differs greatly in its properties from those of the actual single crystal. It is assumed that real crystals have numerous pores and zones of disturbance. Complexes of some thousands of molecules seem to form higher units in crystallised bodies. (See also a lecture at the Danzig Physics Congress.)

Official Publications Received.

Forest Bulletin No 66 (Economy Series): A Note on the Working Qualities of some Common Indian Timbers. By H. E. Kinns. Pp. iv + 43. (Calcutta: Government of India Central Publication Branch) 10 annas; 1s.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 8, Nos. 2, 3, 4: Investigations on Indian Opium, Nos. 4, 5, 6. No. 2: Further Experiments on the Influence of Manures on the Yield and Morphine Content of the Latex from the Opium Poppy, by Dr. Harold E. Annett and Har Dayal Singh; No. 3: Experiments on Oil-Content of the Seed of the Opium Poppy; and No. 4: Studies on the Ash Constituents of Indian Opium, by Dr. Harold E. Annett and M. N. Bose. Pp. 25-51. (Calcutta: Government of India Central Publication Branch) 8 annas; 10d.

Commonwealth of Australia. Bureau of Meteorology, Melbourne. Bulletin No 16: Australian Hurricanes and related Storms, with an Appendix on Hurricanes in the South Pacific. Prepared by Dr. Stephen S. Visser and D. Hodge. Pp. 54+3 charts. (Melbourne: H. J. Green.)

Government of India: Department of Industries and Labour, Public Works Branch. Triennial Review of Irrigation in India, 1921-1924. Pp. ii+43. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1s 9d.

Glass Research Association. Bulletin No. 14, August: A Review of the Work of the Association, 1920-1925. Pp. 106. (London: Wilfrid C. Smith, Liquidator, 48 Coptall Avenue.)

Department of the Interior: North West Territories and Yukon Branch. Canada's Arctic Islands: Log of Canadian Expedition 1922. By J. D. Craig; with an Appendix, Aviation in the Arctic, by Major R. A. Logan. Pp. 27. Canada's Wild Buffalo: Observations in the Wood Buffalo Park. By Maxwell Graham; with an Appendix, A Reconnaissance in the Home of the Wood Buffalo, by F. W. Seibert. Pp. 17+2 maps. Local Conditions in the Mackenzie District 1922. By J. P. Moran. Pp. 19+1 map. (Ottawa: F. A. Acland.)

Tide Tables for the Pacific Coast of Canada for the Year 1926: including Foca Strait, the Strait of Georgia, and the Northern Coast; with Data for Slack Water in the Navigable Passes and Narrows and Information on Currents. (Twenty-sixth Year of Issue.) Pp. 72. (Ottawa: F. A. Acland.) Free.

Tide Tables for the Eastern Coasts of Canada for the Year 1926: including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits; and Information on Currents. (Thirtieth Year of Issue.) Pp. 76. (Ottawa: F. A. Acland.) Free.

Report on Norwegian Fishery and Marine Investigations. Vol. 3, No. 5: Marking av Sei i Nordland sommeren 1921 beretning avgit til Fiskeridirektøren. (Summary in English.) Av Oscar Sund. Pp. 24+3 plates. (Bergen: A.S. John Greigs Boktrykkeri.)

Queensland Department of Mines: Queensland Geological Survey. Publication No 275: Index to Publications No 267 to 274 (Vol. 8 of New Series). By Miss M. G. Wood. Pp. 39. (Brisbane: Anthony James Cumming.)

Memoirs of the Department of Agriculture in India. Veterinary Series, Vol. 3, No. 6: Nasal Granuloma in Cattle. By Prof. V. Krishnamurti Ayyar. Pp. 159-166+9 plates. (Calcutta: Thacker, Spink and Co; London: W. Thacker and Co.) 1 rupee; 1s 6d.

Department of Agriculture, Straits Settlements and Federated Malay States. Bulletin No. 37: The "Mouldy Rot" Disease of Hevea Brasiliensis in Malaya. By F. W. South and A. Sharples. Pp. ii+31+4 plates. (Kuala Lumpur.) 50 cents.

Memoirs of the Department of Agriculture in India. Entomological Series, Vol. 9, Nos. 1, 2 and 3. No. 1: A Contribution towards a Monograph of the Indian Conopsepterygidae (Neuroptera), by Dr. C. L. Withycombe; No. 2: Papers on Indian Tabanidae—vi: The Bionomics and Life-Histories of some of the Common Tabanidae of Pusa; and No. 3: Some Observations on the Life-History and Habits of Phycus brunneus, Wied. (Family Theredidae), by P. V. Isaac. Pp. 80+11 plates. 22 rupees; 4s. Chemical Series, Vol. 8, No. 1: The Quality and Yield of Tobacco as influenced by Manual and other Operations. By J. N. Mukerji. Pp. 26. 8 annas, 9d. (Calcutta: Government of India Central Publication Branch.)

Ceylon Administration Reports for 1924. Department of Agriculture: Report of the Director of Agriculture for 1924. Pp. D52 (Colombo)

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. Edited by W. F. Spear. New Series, No. 24, July. Pp. 194. (London.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 77: Fishes from Natal, Zululand and Portuguese East Africa. By Henry W. Fowler. Pp. 187-268. (Philadelphia.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 818: Terrestrial Magnetism—The Earth's Magnetism. By Daniel L. Hazard. (Special Publication No. 117.) Pp. 52+6 plates. (Washington: Government Printing Office.) 15 cents.

The Brooklyn Institute of Arts and Sciences. Brooklyn Museum Science Bulletin, Vol. 3, No. 3: Revision of the New World Species of the Tribe Donacini of the Coleopterous family Chrysomelidae. By Charles Schaeffer. Pp. 45-165. 1 dollar. Vol. 3, No. 4: Notes on certain Books of Unusual Interest in the Blackford Collection of the Brooklyn Museum. By E. W. Gudger. Pp. 167-172. (Brooklyn, N.Y.)

The Manchester Steam Users' Association for the Prevention of Steam Boiler Explosions, and for the Attainment of Economy in the Application of Steam. Memorandum by Chief Engineer for the Year 1924. Pp. 52. (Manchester.)

Boletín de la Sociedad Geológica del Perú. Tomo Primero. Pp. vi+126+31 lám. (Lima.)

The Government of the Philippine Islands: Department of Agriculture and Natural Resources, Bureau of Science. The Mineral Resources of the Philippine Islands for the Years 1921, 1922 and 1923. Issued by the Division of Geology and Mines, Bureau of Science. Pp. 63. (Manila: Bureau of Printing.)

Canada. Department of Mines: Geological Survey. Memoir 146, No. 126 Geological Series. Retreat of the Last Ice-Sheet in Eastern Canada. By Ernst Antevs. Pp. iv+138+9 plates. (Ottawa: F. A. Acland.) 25 cents.

Proceedings of the Liverpool Geological Society. Session the Sixty-sixth, 1924-25. Part 2, Vol. 14. Edited by C. B. Travis. Pp. xxi+99-105+plates 5-9. (Liverpool.) 5s.

Department of the Interior: U.S. Geological Survey. Mineral Resources of the United States in 1924 (Summary Report). Introduction by Frank J. Katz; Statistics assembled by Martha B. Clark. Pp. ii+103A. (Washington: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 529: Surface Water Supply of the United States, 1921. Part 9: Colorado River Basin. Pp. v+181+2 plates. 25 cents. Bulletin 766: Spirit Leveling in California, 1896-1923. Pp. ii+748. 80 cents. Bulletin 781A: Paleozoic Formations penetrated by Wells in Tishomingo County, North-eastern Mississippi. By M. N. Bramlette; with Notes on Paleozoic Rocks encountered in a Well near Florence, Alabama, by H. D. Miser. Pp. 12+1 plate. (Washington: Government Printing Office.)

Last of Memoirs, Maps, Sections, etc., published by the Geological Survey of Great Britain and the Museum of Practical Geology to 30th June 1925. Pp. 115+5 plates. (London: H. M. Stationery Office; Southampton: Ordnance Survey Office.) 1s. net.

Development Commission. Fifteenth Report of the Development Commissioners for the Year ended the 31st March 1925. Pp. vi+198. (London: H. M. Stationery Office.) 2s. 6d. net.

Memoirs of the Geological Survey of India. Vol. 50, Part 1: Descriptions of Mollusca from the Post-Eocene Tertiary Formation of North-Western India; Cephalopoda, Opisthobranchiata, Siphonostomata. By the late R. Vredenburg. Pp. xii+350+xvi+13 plates. (Calcutta: Government of India Central Publication Branch.) 5.6 rupees; 8s. 9d.

Forest Bulletin No 65 (Silviculture Series): Tables for Bark Deductions from Logs. By S. H. Howard. Pp. ii+11. 8 annas; 4d. Forest Bulletin No. 64 (Economy Series): Summary of Results of Laboratory Experiments with different Wood Preserving Antiseptics (Results of 14 Years' Experiments). By S. Kamesam. Pp. ii+23+5 plates. 1.12 rupees; 3s. (Calcutta: Government of India Central Publication Branch.)

Diary of Societies.

FRIDAY, DECEMBER 18.

SOCIETY OF MEDICAL OFFICERS OF HEALTH (at the Medical Institute, Newcastle-upon-Tyne), at 5.—Prof. H. Kerr: Industrial Hygiene from the point of view of Public Health Administration.—Sir T. Oliver: Industrial Hygiene from the point of view of the Physician.—G. France: Industrial Hygiene from the point of view of the Works Director.—Capt. J. Robinson: Industrial Hygiene from the point of view of the Welfare Supervisor.

INSTITUTE OF TRANSPORT (North-Western Local Section) (at the Midland Hotel, Manchester), at 6.30.—E. G. Garstang: Transport in Connection with the Fishing Industry.

SOCIETY OF DYERS AND COLOURISTS (Manchester Street), at 7.—Prof. E. Knecht: The Effect of Oxidation, of Cotton of Glucose and other Carbohydrates by

SOCIETY OF CHEMICAL INDUSTRY (South Wales College, Swansea), at 7.15.—E. E. Ayling:

SOCIETY OF DYERS AND COLOURISTS (Scottish Restaurant, Glasgow), at 7.15.—J. Marsden:

AERONAUTICAL ENGINEERS (at Royal Society of Institution of Mechanical Engineers (York Philosophical Hall, Leeds), at 7.30.—Prof.

Importance of Close Speed Regulation in Drives. ROYAL SOCIETY OF MEDICINE (Electro-Therapeut Dr. R. E. Roberts and Dr. M. J. Cohen: Paget P. J. Biggs: Methods of Examination of the P.

SATURDAY, DECEMBER 19.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle-upon-Tyne), at 2.30.—J. S. Carson: A System of Mechanical Coal-mining combined with the Adoption of Systematic Timbering, using Composite Steel Props.—Dr. J. N. Williamson and Prof. H. Briggs: Experiments on Fan Casings and Fan Inlets.

MONDAY, DECEMBER 21.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Sir J. J. Thomson: The Intermittence of Electric Force.—Prof. A. R. Forsyth: A Chapter in the Calculus of Variations: Maxima and Minima for Weak Variations, of Integrals involving Ordinary Derivations of the Second Order (To be read by title).—Dr. A. C. Aitken: On the Theory of Graduation (To be read by title).—Prof. C. E. Weatherburn: On Triple Systems of Surfaces and Non-Orthogonal Curvilinear Co-ordinates (To be read by title).

TUESDAY, DECEMBER 22

INSTITUTE OF MARINE ENGINEERS, at 6.30.—C. Hughes: Fuel Injection.



SATURDAY, DECEMBER 26, 1925.

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Early Mental Disorder.

IN continuation of our previous comments (NATURE, November 28) upon conditions of research in mental disorder, it may serve a useful purpose to describe, from a constructive point of view, some further practical aspects of the problem, and to show their bearing upon each other.

At the close of the War the Maudsley Hospital in London, like many others which had been put to army purposes, returned to civil use as a special institution under the London County Council for the treatment of early mental cases. At the same time, the pathological laboratory of the London Mental Hospitals was housed under the same roof. Thus was constituted an organisation for scientific investigation in vital relationship with one for observing and treating the earliest signs of insanity. From the first, no person admitted as an out-patient or to the wards of the Hospital was certified insane either before admission or during treatment by the hospital staff. Residence in the Hospital was a purely voluntary matter, and the divorce from legal procedure for compulsory detention was absolute. Patients seek advice and treatment in the same sense as they seek relief from purely physical symptoms at a general hospital; and, precisely as in a general hospital, admission to the wards may follow reference by a physician or attendance at the out-patient department of the Hospital.

Little imagination is needed to realise the differences between a voluntary mental hospital of this kind and other voluntary hospitals. There are peculiarities inseparable from responsibility for the welfare of persons who, from a medical if not a legal point of view, may not be strictly accountable for their actions. There are also the limitations inseparable from public control, to which general hospital physicians and surgeons are not subjected. But above all is a difference which even alienists themselves, trained for the most part in the shifts and inconveniences associated with sole care of hundreds of mental patients of all sorts and conditions, do not always appreciate. In general hospitals, except in comparatively rare cases, diagnosis is made relatively rapidly, and treatment, apart from mornings in the surgical theatres, and such measures as can be handed over to subordinates, takes actually little time. Fifty patients share the attentions of clinical clerks, houseman, assistant and chief, and the treatment of out-patients often entails further appointments to the staff. In mental disease it is recognised that if there is a physical cause, primary or contributory, it is obscure. Hence, even from a physical point of view, every patient in a hospital for the treatment of early mental cases is potentially in the position of the

rare, difficult cases of general hospital practice. Add the exhaustive and intimate personal investigation into history and behaviour indispensable to establish the past and present mental condition of every patient, and it is clear that to fulfil the first of its functions the special mental hospital should be staffed not less but more generously than any other kind of existing hospital, and by men of equal specialist competency, one with another, wholly responsible for their own cases. This is not an ideal but a necessity.

Treatment, however, is not the sole function of the voluntary mental hospital. Every person enabled to carry on his own, or any, avocation in society means a social saving of the work of two, and the importance of any improvement in medical efficiency here is obvious. But possibly the greatest opportunity in relation to the small voluntary hospital is for the observation of the early signs of disorder and the turning of the knowledge thus gained to scientific use. A passage in Lugaro's "Problems in Psychiatry" has special application in this connexion.

"In practice," he wrote, "it is not possible to limit one's attention to one single branch of a complicated subject, and all great pioneers of science have dived deep into two or more branches of knowledge with equal success and skill. There is a physics and a chemistry, but pure physicists and chemists do not exist. Anatomy can be separated from function, but the anatomist must be conversant with the latter. The physiologist does not understand his science without anatomy. But in no science do so many sciences dovetail into each other as in psychiatry. Therefore the alienist must—as much as the time at his disposal and his individual capacity permit—take an active part in work developing in neighbouring fields of research, cultivate other sciences and help them to progress, in order to further the progress of his own."

Every serious worker among the mentally disordered is in the position of such a pioneer. The foundations of his science have yet to be laid. They cannot be laid among the chronic insane; but only by the minute study of the developing disorder: otherwise as well seek the origin of species in the anatomy of a single type.

All these advantages are capable of being shared by the admission wards of the large mental hospitals, although the fact of legal certification goes very heavily against the establishment of relations in which freedom and candour predominate over fear and suspicion between patient and doctor. Setting aside the empty charge so commonly made against the institution of early treatment centres, that they attract the hysterical and neurotic patient—as though a surgeon might disdain to treat cut heads—it is frequently alleged that the admission wards of large asylums are now in reality such centres. There is every appearance of truth in this contention, excepting

the essential appearance of similarity of aim and result. Certification is a legal, not a dividing, line. Little as we know of the real nature of such disturbances, we do know that the most maniacal behaviour is quite consistent with ultimate and even early recovery. Many early cases, and as many that are recoverable, reach the admission wards of asylums.¹ This fact alone links into an organic unity the principles of early treatment wherever it is carried out.

The characteristics of the small voluntary hospital are not exclusive. What is needed is that such centres as the Maudsley Hospital should be less special than they are. Large and important as their sphere might be, provided always that they were adequately equipped for their complex function, there must remain the social necessity for compulsory detention of some persons even in acute stages of disorder. Their treatment entails its own problems, and offers as profitable a field for investigation into fundamental problems as any. It would be a grave mistake to remove all responsibility for the solution of mental problems from asylum staffs.

Like so many other great social problems, the question of the advancement of our knowledge of mental disorder is fundamentally one of money. Without the clear recognition that the organisation of ordinary medical practice cannot appropriately be applied to mental disease, and that psychiatry cannot progress without adequate endowment, no considerable advance is possible.

Labour and Primitive Economics.

Primitive Labour. By L. H. Dudley Buxton. Pp. viii + 272. (Methuen and Co., Ltd., 1924.) 7s 6d. net.

UNDER the surface storms which have for some time been troubling the once calm waters of anthropology—as the contest concerning the origins of marriage, the differences of opinion about totemism, the fight between diffusionists and evolutionists—there has taken place a much more radical change in method, aim, and argument. More and more has the substance of serious anthropological work come to consist of sociological analysis of primitive culture. The nature of primitive organisation, the types and phases of economic activities, the relations between the economic and the religious aspect, or between magic and practical arts and pursuits, are now studied as empirical problems and not as pretexts for reconstruction and hypothesis. The new anthropology aims at the

¹ During 1924, 22,758 persons were admitted to County, District, and County Borough Mental Hospitals, and 6751 were discharged recovered. If transfers and readmissions are excluded from consideration, the proportion, per cent., of recoveries to admissions in 1924 was 34.3 per cent. The number of certified insane in London County Mental Hospitals in 1924 was 19,269. The figure was given inaccurately in NATURE, November 28, p. 775.

understanding and explanation of culture rather than at the establishment of "origins," "contacts," and "diffusions"; it moves exclusively in the realm of ascertained fact and avoids conjecture; it can yield results applicable in practice and not mere speculations of purely antiquarian interest.

Of all such positive subjects, primitive economics has been perhaps most neglected, in Great Britain at least; while within this subject the problem of primitive labour has scarcely been touched at all. It is a great privilege for a writer to be able to take up an entirely new question. His is naturally the duty of summarising all the preparatory and relevant work done, of formulating the problem, of making his original contribution, of setting the task for his successors. Unfortunately, it cannot be said that the author of the present work has fulfilled any of these tasks in a satisfactory manner. It would be impossible even to frame the problem on the basis of his contribution.

In order to do this it is important to have a clear definition of the concept with which we are dealing. What is *labour*? The reader of Mr. Buxton's book will find no definition, and the word is used loosely with a variety of meaning to cover "invention," "industries," "pursuits," and is usually identified in a cryptic manner with "arts of life," which, I take it, covers any form of activity whatever. (Ch. i.; also pp. 14, 63, 248, 250, 264-265 *et passim*.) But to identify labour with activity in general is, from the outset, to confuse the issue. For is it not in the harnessing of human energies, in the disciplining of purposeful and systematic activity, devoted to culturally valuable ends, that any real advance consists? It is only after we have distinguished labour from purely animal instinctive movement on the one hand, and from recreational and sportive activities on the other, that the problem emerges. Even in the satisfaction of his wants, such as search for food, provision for clothing and shelter, man may act instinctively on the animal pattern, or else reach his goal by culturally standardised types of behaviour. It is only the latter which I suggest should be regarded as forms of labour in the science of culture.

The anthropological problem, therefore, would be: What is the relation, at various stages of development, of the unregulated activities to those standardised by custom, and what part within the latter is occupied by work devoted to the production of concrete cultural values? For it is the achievement of something tangible and useful which must enter also into the definition of labour. In the first place it will be, of course, the satisfaction of man's primary wants: the search for food and its preparation; the procuring of raw materials for clothing, weapons, and direct objects of use. To this the lowest savage adds certain material

goods which are not for consumption, but really belong to the primitive forms of capital—implements, arrangements for storing and preserving food, traps, hunting weapons, and so on. To define the savage, therefore, as Mr. Buxton does, by the fact that he "has no means of acquiring more wealth than he can carry about on his person or on the persons of his family" (p. 9), is incorrect even in regard to the most primitive man known, and would exclude from the inquiry all the most important facts about middle and higher savagery. Again, even amongst the lowest savages, there is work devoted to the production of what might be called luxuries—objects of art and monuments of culture—personal ornaments, paintings, and rude sculpture, stone memorials and graves, objects of cult and ritual. We may, therefore, define labour as purposeful systematic activity standardised by tradition and devoted to the satisfaction of wants, the making of means of production, and the creation of objects of luxury, value, and renown.

If, however, labour is distinguished from other activities by its purpose, the question emerges: What is it that, in culture, drives man to strenuous, prolonged, and very often unpleasant effort? Here the problem of labour can be treated only against the background of the psychological problem of value. What are the effective incentives to effort? In what way are they related to instinctive drives and how far are they transformed by culture? It is obviously futile to discuss labour except as a part problem of economics. The early forms of labour are intimately correlated with the manner in which economic value came into existence. In fact, the inquiry has to burst the bounds even of the widest economic analysis and to consider how other motives, above all those of magical and religious character, have pushed man towards certain pursuits, established new values for him, and thus given him new forms of labour. The ingenious hypotheses of Eduard Hahn about the origin of domesticated animals and about the connexion between higher agriculture and religious cult; the views of Grosse about the influence of family life on economic pursuits; the recent contributions of Max Weber and Richard Thurnwald, form already a body of knowledge upon which any writer who treats of the problem of labour must take his stand. All this important research is unmentioned by the writer of the book under review.

From our definition of labour it also results that this type of activity, since it does not run on the lines of instinct and play, must involve a certain amount of resistance on the part of the organism. In other words, as we all know—and even the savage would agree with us—work is unpleasant. In primitive culture we find

indeed that man works very erratically, sometimes with the greatest efficiency, sometimes in a very unsatisfactory manner. A closer analysis shows that the efficient work is very often due to what might be called a palliative concomitant, some stimulant which carries man over the fatigue, tedium and monotony, over the need of recurring effort. An excellent study of this subject in one of its aspects has been given to us in Karl Bücher's "*Arbeit und Rhythmus*" (1899, 2nd ed.). No student of the problem should neglect this work, and had Mr. Buxton read it carefully and inspired himself with its methods he might have given us some data at least from the extremely rich inventory of the various concomitant stimuli, such as rhythm and music, drugs, work in company, emulation and example, importance of effective leadership and the use of rewards, material and moral.

The stimulating influence of work in company or of work under compulsion must be strictly kept apart from another and much bigger subject, that of the organisation of labour. Culture consists not only in the greater efficiency of effort, nor yet in the standardisation of this effort only, but also in the co-ordination of activities. The most primitive societies must have had a tradition of labour as well as a tradition of knowledge, belief, social organisation, and art.

Continuity in work transcends the limits of individual life, since not only the implement, the knowledge of material surroundings, but also the mode of working, the tricks of trade, and even the morals of hard and industrious labour must ever be engrained by the elder in the younger generation. This obviously implies some social organisation upon which the transmission of workmanship and education in work could have been based. This probably also led to the simplest forms of co-operation, those between the old and weak yet experienced on one hand, and the strong novices on the other. Since again transmission of workmanship must have been associated with kinship and marriage, the earliest forms of organised labour were to a great extent associated with the relation between husband and wife and parents and children.

The isolated household economy, however, was never the exclusive form of production even in the most primitive tribes. Prof. Karl Bücher, who develops an evolutionary scheme of human industries, would like to place at the beginning an even more primitive type of existence, that of isolated search for food. This is unquestionably a fictitious conception; even in simple search some order if not organisation is necessary. The roaming-grounds of every group are subject to the exclusive though collective rights of this group. Within this territory the very natural conditions such as the seasonal abundance of food, the advantages of system-

atic search, the technicalities of many proceedings in food-collecting, must have imposed a number of rules, dictated by knowledge and enforcing order and rudimentary forms of co-operation. The observations about food-collecting which I had opportunities of making among a number of Papuan and Melanesian tribes in New Guinea gave me the conviction that even among more primitive food-gatherers some organisation of labour must exist. The mere psychological factor which makes isolated search exceedingly tedious, and search in groups stimulating, refreshing, and more effective, would lead to the same conclusion. It is difficult to imagine collective work done in dead earnest, subject to natural conditions and guided therefore by knowledge and experience, which would be entirely unorganised.

There is, however, even a weightier reason for eliminating the concept of isolated search or of independent household economy. Culture stands and falls with the strength of tradition, with the quantity and quality of all that is transmitted from one generation to the other. A society cut up into independent families would, therefore, mean a tradition split into a number of extremely thin and precarious threads of cultural continuity. So that even in the lowest stages of development a society which would at least seasonally congregate, come into contact collectively, compare their practices and perhaps exchange material goods as well as ideas, would have a good cultural advantage over an atomised society. Moreover, a community which would be always ready to mobilise for defence or aggression, or in case of natural catastrophes, would always have a great advantage over its neighbours. This explains why we find in every savage community, described with sufficient accuracy and detail, periodic regular gatherings for religious, festive, or warlike purposes.

We are unfortunately not informed in what way the commissariat of such big gatherings is run. Yet it is clear that in a society like the Central Australians, who lead apparently a hand-to-mouth existence, and have to roam over big tracts of country in small bands in order to survive, some extraordinary economic feats must be performed if the hundreds of blacks who congregate for months for an Engwura or an Intichiuma ceremony have to be fed by those who are not busy in the ritual. There is here obviously a conundrum of the first order in primitive economic theory—not to speak of the practical difficulties to the blacks themselves—and yet our authorities who have given page after page of ceremonial detail have passed it over completely! So helpless is the first-hand observer in the absence of theoretical inspiration; as a field-worker, I may be allowed to say so. In any event, the

fact, of big periodical gatherings among the most primitive tribes forces us to the conclusion that they have elaborate forms of economic organisation, more especially of organised labour. What is more, if they can organise on exceptional occasions, surely they must have some habits of organised work in their daily existence as well.

When we come to slightly higher stages, a great deal of collective and organised effort is required in such pursuits as communal hunting and fishing, any form of tropical agriculture, or the building of dwellings and canoes. In the case of such societies, we have at our disposal quite a respectable number of observations, and it would be possible to treat the subject not only tentatively so as to stimulate research, but also to advance certain positive conclusions. When a number of people work together at the clearing of the scrub, at the cutting down of a tree, or at the construction of some object, the question first arises—by what interest are they moved? Does every one receive some share, or even an equal share; or are they impelled by some *esprit de corps*, some unselfish motive of common good? The problem of incentive in communal labour leads therefore immediately into problems of ownership. Anthropology has perhaps discussed this problem more carefully than any other of primitive economics, but the relation between labour and prospective use and advantage still awaits to be competently treated, and more particularly to be freed from the ill-defined and misleading concept or word "Communism."

This is the place to attempt at least a tentative definition of what is understood by organised labour. In savage societies with a slightly higher culture, there are many tasks which transcend the forces of one individual; yet when several people co-operate, if there is not to be confusion, they must first of all be placed spatially and their respective contributions synchronised or placed into a sequence. In the simplest collective work, such as common clearing of bush, the pulling of a log, the planting of a garden or weeding, the people distribute themselves, and there are some means, either by personal arrangement or by customary signalling, of synchronising the pull of the log, of systematising the complete clearance of the bush, of ensuring an even distribution of the seed in the ground.

In more complex activities, however—imagine a canoe in rough weather, a fishing-team at work, a fighting force manœuvring—there is a necessity not only of spatial and temporal co-ordination, but also a dovetailing of the individual contributions to the common task. According to personal capacity, according to the position at that moment, according to social status, the various members of the organised team act each in the prescribed manner. There is among them, however, one

whose task is not so much a special part of the common labour as the guidance of the whole. This is the leader. Leadership is necessary in certain enterprises, because of special knowledge, experience, and mental qualities; in others because of the need of one person to signal or indicate the sequence of events; in others again out of sheer deference to rank, status, and power. In primitive societies, moreover, there is one important element associated with control of work, that is the influence of magic. Magic indeed not only very often supplies the title to leadership, but seems to be one of the most important principles in the organisation of labour by supplying the stimulus, indicating the sequence, and commanding belief and subordination to the man in charge. We may, therefore, define the organisation of labour as the sum total of the factors which command the spatial and temporal placing of tasks; the distribution and dovetailing of functions, and, again, the integration of these functions by customary schemes, mutual agreement, and leadership.

The problems of organisation, therefore, would refer to the modes in which tasks are apportioned, to the nature of leadership, to the relation between technical and social rules, knowledge, and social prerogatives, finally to the study of magic as the controlling principle of labour. All this, however, would be futile if it were discussed without reference to the economic distribution of profits. For it is the inequality of labour, coupled with the inequality of gain, which forms, at the beginnings of civilisation, the foundations of progress. The best modern work in field anthropology establishes the importance of the economic factor in the foundation of political power, of rank, and of all forms of cultural eminence. The conditions as we know them from north-west America, from many African tribes, above all from Oceania, and more especially from Melanesia, reveal the accumulation of wealth as one of the strongest social incentives, the economic and ceremonial handling of valuables as one of the motives round which big social achievements crystallise, and the beginnings of a "leisured class" as the carrier of culture. The chief very often acts as a sort of tribal banker. All that Mr. Buxton has to say on this important subject is that "the chief's duties usually lie in other directions than those connected with arts of life" (p. 17), a statement succinct but not correct.

What has been said might perhaps be summarised in the statement that primitive labour has a technological aspect which leads to a disciplining and co-ordination of activities. This again implies from the earliest stages an organisation of labour which must be studied in its sociological context as well as with reference to the tribal economies. This, once more, leads to the psychological analysis of incentive, concomitant stimulus to

labour, value, and ownership. Mr. Buxton disregards the sociological, the economic, and the psychological problems. The technological aspect is treated only in a fragmentary descriptive manner. As a matter of fact, the second and third parts of the book, which are frankly descriptive—they consist to some extent of personal reminiscences told in a vivid and unassuming manner—are, within their limits, better perhaps than the more ambitious first part. That rapid impressions and anecdotal reminiscences as scattered throughout this volume have little anthropological value as field work, need scarcely be said. In the first part (pp. 1-72) we miss the formulation of the problem, even an approximate definition of terms and any consecutive argument. We remain under the impression that the book has been very rapidly written when we are told, for example, that "the house, then, will protect from the weather and provide a place wherein to live" (p. 60), or "clothing, therefore, may be considered at least in part as one of the arts of life" (p. 61)—and in such statements the book abounds. We feel that the art of omission has been neglected in writing it. To quote one more dictum: "Intimately connected with the arts of life, yet hardly forming one of them, may be grouped that type of craftsmanship which devotes itself to ornament and relaxation" (p. 63). How "relaxation" can be a form of craftsmanship or how craftsmanship is to be excluded from the "arts of life," passes my comprehension.

Disappointing also, in a book like the present, is the almost entire neglect of the most important works touching upon the subject. The names of Dargun, Ed. Hahn, Bücher, Schurtz, Cunow, Grosse, Laveleye, Lewinski, Thurnwald, and Max Weber are not mentioned. This is the less to be excused since there are in existence excellent brief resumé of the work done so far—to mention only "Die ethnologische Wirtschaftsforschung," by Pater W. Koppers, in *Anthropos*, 1915-16, and "Die Gestaltung der Wirtschaftsentwicklung von ihren Anfängen heraus," by R. Thurnwald, in "Erinnerungsgabe für Max Weber," Band i., 1923, both with excellent bibliographies.

The problem of labour, therefore, still awaits its theoretical launching. This is so much the more urgent since observations will not be forthcoming until the theory has erected a number of hypotheses, suggested a series of questions, and goaded the interest of field-ethnographers by a number of more or less extravagant assertions. It would be highly desirable that the subject of labour should be well under the control of theory and of empirical study, for it is one of practical importance in Colonial legislation and in the regulation of the manner by which native races are to work for or with the white man.

B. MALINOWSKI.

The Arts of Husbandry.

Actual Farming: its Processes and Practice. By W. J. Malden. Vol. 1. *The Farm: its Nature and Treatment.* Pp. 207. Vol. 2. *Croppings, Pastures and Weeds.* Pp. 295 + 11 plates. Vol. 3. *Live Stock, Labour and Marketing.* Pp. 240. (London: Ernest Benn, Ltd., 1925.) 50s. net.

THE task of writing a treatise covering the whole art of husbandry as it appears to those many sorts of farmers who practise it must necessarily be a formidable one. There is so very much to be said and so many points from which the same facts may be viewed, that the work may easily develop into an encyclopedia. From time to time courageous men have appeared who have endeavoured to capture and to set upon paper all that curious mass of information and tradition which, when seasoned with common-sense and intuition, goes to make up a farmer's professional equipment. Such classics as "The Book of the Farm," or in a lesser way Fream's "Elements of Agriculture," are the result of such bold projects in the past, and it must be admitted that in so far as the written word has any influence at all upon the development of practical farming, they have proved their usefulness.

Mr. W. J. Malden, who is already well known as a writer on grassland farming and sheep and has an unusually wide personal experience of farming both in its practical and more definitely scientific aspects, has endeavoured to deal with the same subject in its more recent developments. His book is quite well-named, for its appeal is wholly to the working agriculturist and not at all to the man of science. Mr. Malden thinks as a farmer and feels as a farmer, and one can but regret that he does not write so well as some of those predecessors in agricultural literature from whose works he quotes. Many who read these three volumes will regret that the means of expression is not equal to the knowledge displayed in them.

The arrangement of so large a work is itself a matter of great difficulty, and in this particular the author has adopted a plan which should appeal to that body of his readers who may require his book as a work of reference. The whole is divided into three volumes, each with a sub-title which expresses its general purport. The first of these deals with the farm, its nature and treatment, the second with croppings, pastures and weeds, and the third with live stock, labour and marketing. The further subdivision into chapters is well done on lines which are familiar to students of agricultural literature. The first volume is probably the most valuable of the three, for some of the aspects of farming found in it are those which receive too little attention from contemporary writers.

Mr. Malden's view of the relation of the farmer to the rest of the community is one that is not uncommon among farmers, but is seldom adequately expressed. He says that "the farmer has every one as a critic," and that he has to carry on an extremely complex business and an unending war with the climate, in face of the freely expressed opinions of the mass of his uninstructed fellow-countrymen. Open criticism, even when it is ill-informed, matters very little when it is not accompanied by power of one sort or another. In this case of the farmer, the critics represent that urban majority which must influence the political views of any government to a very great degree. Farming and politics are widely removed from each other in most respects, but political neglect or misunderstanding can make the farmer's task very much more difficult than it need be.

The attitude of farmers towards change and so-called agricultural progress is very generally misunderstood, and Mr. Malden finds space to express a view which will gain support among those who have some knowledge of farming conditions, and of the ill-conceived and expensive reforms which are sometimes urged upon agriculturists. The history of agricultural development in Great Britain during the past fifty or sixty years shows that great progress has been made in the application of the sciences to the business of farming, and that the farmer of to-day is in a far better position to solve his problems of crop and animal husbandry than was his great-grandfather. Unfortunately, a closer study of the course of progress reveals the fact that this advance has been made at very great cost, and that a large number of individuals have been ruined in the process. So many well-meaning but unwise people, and so many interested rogues, have set out to advise farmers in the development of their businesses; so much incomplete discovery and unbalanced recommendation has been lavished upon agriculture, that the sturdy conservatism of the farmers might very well have become hardened to an incredulous contempt for all new ideas. That this has not happened is well shown by the present development of agricultural education and research, which depends upon the support of farmers all over the kingdom. Mr. Malden quotes from Wren Hoskyns to show that real progress finds a welcome on the farm as elsewhere, and that apparent lack of enterprise is often only wise caution on the part of the farmer. The beginning is worth quoting again:

"Ye ardent go-aheads! who expect every new argument to tell at once—every intellect to yield at first onset, every new plan to be tried by everybody—learn to wait: and you will find that there is much more chance of your notion being overtaken than overlooked, much more likelihood of your having to reclaim than to reassert a single hint that was ever good for anything."

CLEMENT HEIGHAM.

Optical Methods in Biology and Chemistry.

- (1) *Handbuch der biologischen Arbeitsmethoden*. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 161. Abt. 2: *Physikalische Methoden*, Teil 1, Heft 5. *Photometrie*, Tyndall-*Photometrie*, *Zeitmessungen*, Von Paul Hirsch. *Colorimetrie*. Von Heinrich Kessler. Pp. 619-736+xvi. (Berlin und Wien: Urban und Schwarzenberg, 1925.) 5.70 gold marks.
- (2) *Optische Messungen des Chemikers und des Mediziners*. Von Dr. Fritz Löwe. (Technische Fortschrittsberichte: Fortschritte der chemischen Technologie in Einzeldarstellungen, Band 6.) Pp. xi+166. (Dresden und Leipzig: Theodor Steinkopff, 1925.) 6 gold marks.

RAPID developments have taken place during recent years in the application of optical methods in various branches of science. For the efficient utilisation of such methods, the investigator or practitioner requires a knowledge of the functions and possibilities of the various instruments that are available for use in his particular sphere of work. To meet these requirements, modern textbooks professing to give a complete treatment of any subject usually contain a full account of suitable instruments and of the method of using them. As an alternative to the inclusion of elaborate instrumental details in a comprehensive treatise on any branch of science, the preparation of separate monographs dealing with the development of the instruments and their specialised applications has much to commend it. Revised editions of such monographs are more easily produced and more readily purchased, and the student or investigator can select those which deal with that branch of the subject in which he is most directly interested. The two books before us provide an example of each method.

(1) The first forms a small section of the second volume of a thirteen-volume treatise on methods and technique in biology, many parts of which have already been noticed in our columns. Two chapters are devoted to photometry and Tyndall photometry or the measurement of the scattering of light by extremely small particles held in suspension in the medium through which the light is passing. The theoretical treatment is adequate and the main types of instruments are well described; but many of the most recent developments are omitted and little information is given on the application of the instruments in particular cases. No attention is paid to the attempts which have been made to place photometry on a more accurate basis by the use of instruments which respond to light in a manner comparable with that of a normal

human eye. The appendix on spectrophotometry contains very little indication of the use of instruments which enable quantitative measurements of absorption to be made in the ultra-violet and the infra-red regions of the spectrum.

In making these criticisms we must, however, bear in mind that we are examining a small section of a large treatise, and it is possible that many of the items now omitted may find a place elsewhere in the completed work. Thus, in the chapter on Tyndall photometry, no mention is made of recent work on nephelometric methods in biochemistry; but the list of sections in course of preparation includes one on nephelometry, which is grouped with ultramicroscopy. The third chapter contains an instructive account of several types of stop-watches. Chronographs and microchronographs are not included, but reference is made in this connexion to another volume of the work.

The chapter on colorimetry deals with the simpler and more frequently applied part of the subject, namely, the determination of the comparative luminosity of the total light transmitted by a coloured body, as distinct from the calculation of the colour of the light. Here the chemist will find a considerable amount of information with regard to instruments and methods which permit him to use colour estimations in various branches of analytical work.

(2) The object of Dr. Löwe's book is to provide, in a readily accessible form and at a reasonable price, a comprehensive presentation of the advances that have been made since 1914 in optical instruments and their application in chemistry and medicine. The book admirably fulfils its purpose. The subjects dealt with are spectroscopy, refractometry, and interferometry. Developments in these regions have been particularly rapid during the period under review, and the author has had plenty of material with which to work. The selection he has made is good and the treatment is excellent.

Each section of the work contains an account of recent improvements in instruments and their employment in the routine examination of solids, liquids, and gases, and in special investigations, together with tables of constants for use in the interpretation of the results of observations, and a useful bibliography. These should prove of value to the worker in any branch of analytical chemistry. The author emphasises the advantages to be derived from a more extended use by chemists of the facilities which optical methods provide for making quantitative measurements. Such methods are undoubtedly neat and rapid, and this admirable survey should tend to popularise their use. In doing so, it will serve a very useful purpose.

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Our Bookshelf.

Biologie der Flechten: Entwicklung und Begriff der Symbiose. Von Prof. Dr. Friedrich Tobler. Pp. viii + 266 + 1 Tafel. (Berlin: Gebrüder Borntraeger, 1925.) 13.50 gold marks.

THE original intention of the author was to write a complete account of the lichens, but in this he was forestalled by the publication of Miss Lorrain Smith's "Lichens," with the result that the present volume is confined to a survey of their biology. The historical and modern aspects of the subject are treated as a connected whole and discussed in the light of the most recent work. A full bibliography is given at the end of the book, with brief notes as to the contents of most of the papers.

The author regards the lichens as essentially a biologic rather than a systematic group, the keynotes to the whole volume being metabolism, symbiosis, and the relation of external conditions to the balance of the two symbionts. These views are brought out in discussions on such problems as the relative biologic and systematic significance of soredia and isidia—vegetative methods of multiplication, which are affected by external conditions but occur only in certain lichens, suggesting that their formation may be associated with particular structural types of cortex. The section on physiology includes a survey of the lichen acids, which are interesting as indications of the peculiar metabolism of lichens, and also useful for the identification of lichens, owing to their characteristic colour reactions with certain reagents.

The lichens are regarded as a synthetic group and one particularly favourable for the study of symbiosis. Illustrations are given of all stages from a loose association of fungus and alga to the complex types of symbiosis, where the relationship of the two symbionts is so intimate as to produce a peculiar and characteristic type of morphology and metabolism. This relationship is again closely bound up with external conditions—particularly light and moisture—extreme changes in which are liable to destroy the balance of the two symbionts.

The British Hydracarina. By Chas. D. Soar and W. Williamson. Vol. 1 (Ray Society Vol., No. 110). Pp. x + 216 + 20 plates. (London: British Museum (Natural History), 1925.) n.p.

ONCE more we are indebted to the Ray Society for an arachnid monograph. Instituted in 1844, Blackwall's classic work on spiders was one of the products of its youth. In the 'eighties it gave us Michael's Oribatidæ, to be followed at the beginning of the twentieth century by the same author's Tyroglyphidæ, and now we have the first instalment of the Hydracarina.

The present volume begins with a short historical section, for some reason only brought up to 1842, though later workers have some notice when classification is discussed. An interesting chapter on general characters and life-history follows, and makes it abundantly clear that there is here a large field for further research. The complications introduced by parasitism on the early instars of insects which presently leave the water are responsible for most of the gaps which still

exist in our knowledge of the habits of these curious creatures. The Koenike-Viets classification is adopted without comment, and three families are recognised—Halacaridæ, Limnocharidæ and Hygrobatidæ. Precedence is given to the Limnocharidæ, and about eighty species are dealt with in 126 pages of text, followed by twenty useful—if not sumptuous—plates.

Messrs. Soar and Williamson have begun their task well, and the monograph will be necessary to all interested in this rather isolated group. We confess to finding occasional obscurities of language. For example, "our observations on the hatching of *P. longipalpis* extended over seventeen days" (p. 24) appears from the context to mean that seventeen days was the incubation period; and what is the precise value of observations "stated to have been made by Piersig"? These, however, are small blemishes. We are grateful to the authors and to the Ray Society, which appears to be establishing a "corner" in Acarina. May we hope in due time for a reduction of the chaos which exists in the Gamasidæ and the Trombididæ? C. W.

An Introduction to Palæontology. By Dr. A. Morley Davies. Second impression. Pp. xiii + 414. (London: Thomas Murby and Co.; New York: D. Van Nostrand Co., 1925.)

WE welcome a second impression of the useful little introduction to the study of fossils by Dr. Morley Davies. It is, indeed, a most practical handbook both for the student of geology and the amateur collector, and is admirably designed to give an insight into the methods of palæontological science. It is not a systematic treatise on the various groups, but shows clearly how each is to be studied, and it provides a series of synoptical tables of classification which will suffice for those who are chiefly concerned with fossils as indicators of the age of rocks. There are also in the appendix synopses of the divisions of geological time and the stratigraphical distribution of fossils.

The second impression of the book differs little from the first, except that certain errors have been corrected. It still retains the birds curiously as an order of reptiles intercalated between the crocodiles and pterodactyls. There is also an oversight in describing insects in amber as preserved by the "antiseptic character" of this substance: they are never preserved—they have merely left cavities where they were originally embedded. The descriptions, though always concise and clear, are sometimes overburdened with technical terms which are liable to repel rather than attract the beginner and amateur. One, however, who has plodded through the book with actual specimens of the fossils referred to, will be amply equipped to use special treatises and proceed with independent research. A. S. W.

Department of Scientific and Industrial Research: Radio Research Board. Special Report No. 3: Variations of Apparent Bearings of Radio Transmitting Stations. Part 2: Observations on Fixed Stations, March 1922–April 1924. By Dr. R. L. Smith-Rose. Pp. viii + 107. (London: H.M. Stationery Office, 1925.) 4s. 6d. net.

THIS report discusses the progress of the investigation into the variations of the apparent bearings of radio transmitting stations from March 1922 to June 1923,

when the observations on the longer wave-lengths ranging from 2000 to 9000 metres were discontinued. Observations, however, made at Lerwick, Shetland Islands, from July 1923 to April 1924 are included.

Experiments on the shorter wave-lengths are to be published in Part 3.

The results with the longer wave-lengths prove that when the waves travelled overland, distances ranging from 30 to 200 miles, abnormally large variations were recorded during night time. For distances less than 30 miles, the majority of the direction finder readings had an inaccuracy of about 2°. When the path between the transmitting and observing station is entirely oversea, the errors in the observed bearing were found to lie within the 2° limit for distances up to 100 miles. For most navigational purposes this accuracy suffices. It was found that, within the limits of the experiments, no appreciable effect on the results could be attributed either to the wave-length or to the use of damped or undamped waves.

The Elements of Internal-Combustion Engineering. By Telford Petrie. Pp. xi + 236. (London: Longmans, Green and Co., 1925.) 10s. 6d. net.

AMONG the available text-books on the theory of the internal combustion engine, there are few which present a good account of the subject within a moderate compass and can be recommended to a student in his undergraduate course. This book would appear to satisfy this requirement and is a worthy contribution to the subject. The first three chapters give a brief historical sketch and a descriptive account of the cycles employed in the various types of gas and oil engines now in use, including the Still engine and the Humphrey gas pump. The next five chapters contain a good account of the thermodynamics of the subject, including a chapter on variable specific heats so far as they affect the transformations in an actual engine, the whole of which is well arranged and clearly written.

In the remaining chapters, such matters as the formation of combustible mixtures and temperature effects are dealt with. In the former case the account contains much useful information relating to combustion which should prove of considerable interest to designers as well as to students; in the latter, however, the treatment is necessarily rather superficial, as the various subjects which are included in it could scarcely be dealt with satisfactorily in the space allotted to them. A chapter on the possibilities of development and a collection of good examples conclude the book. E. H. L.

Primer of Arithmetic for Middle Forms. By E. M. Marzials and N. K. Barber. Pp. xii + 262. (London: Oxford University Press, 1925.) 3s. 6d. net.

THIS book is intended to follow a preliminary course up to compound rules, practice, and unitary method. It has many excellent features which make it worthy of consideration by all teachers, but a serious defect is the neglect to train pupils in estimating for themselves the degree of accuracy which may be expected of their results; they are invariably given the number of significant figures required in the answer. It is regrettable that the absurd questions on finding the cost to the nearest penny of papering rooms have not been allowed to die a natural death.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Violent Spore-discharge in *Tilletia Tritici*.

Tilletia Tritici and *T. laevis* are fungi which cause the well-known stinking smut disease or bunt of wheat. An affected wheat grain becomes transformed into a sack filled with several million, closely packed, minute, brown chlamydospores which, in the mass, have the odour of decaying fish. These spores become powdery and, under natural conditions, are passively dispersed by wind and rain. In the artificial process of threshing, the smut-balls are broken open and much of the chlamydospore-powder becomes adherent to the outer surface of the sound wheat grains. When smutty grains are planted in the soil, the fungus attacks the wheat seedlings and once more gives rise to the smut disease. Farmers in Canada and other countries treat the seed-wheat with formalin or some other poisonous substance. This kills the chlamydospores and greatly reduces the incidence of the disease.

When a chlamydospore germinates on a wet substratum (Fig. 1, A), it gives rise to a short germ-tube or basidium (promycelium) which at its apex produces a crown of from four to sixteen slender rod-shaped structures, called by Brefeld and others primary conidia. These conidia have been regarded by botanists in general as morphologically equivalent to the basidiospores of mushrooms and of rust fungi.¹

The primary conidia, often while still on the basidium as illustrated by Brefeld,² conjugate in pairs, each pair forming an H-shaped structure. The work of Rawitscher³ has shown that, during conjugation, a nucleus present in one of the two conidia passes via the bridging hypha into the other conidium, so that this becomes binucleate. The primary conidia readily become detached from the basidium-body which has borne them, but they are never discharged by that organ in a violent manner.

Each H-shaped pair of primary conidia, while still attached to the basidium-body, or after becoming detached, may put out a short sterigma at the end of which there is developed a sickle-shaped spore, called by Brefeld and others a secondary conidium (Fig. 1, A). Or, if malt-agar or other suitable nutrient medium be supplied, each H-shaped pair of primary conidia may put out a germ-tube which branches and rebranches for a long time and produces singly, at intervals along its hyphae, many scores or hundreds of the sickle-shaped secondary conidia (Fig. 1, B). Each sickle-shaped conidium is produced aerielly on a short conical sterigma to the end of which it is attached in an asymmetrical manner. As in the basidiospores of mushrooms and rust fungi, the axis of the basal part of the conidium is inclined to the axis of the sterigma at an angle of about 45°. Hitherto, no one seems to have suspected that the sickle-shaped secondary conidia are the basidiospores of the stinking smut fungus.

One of us (A.H.R.B.) was struck by the great resemblance of the sickle-shaped secondary conidia and their sterigmata to the basidiospores and sterig-

mata of the Hymenomycetes (mushrooms and toadstools),⁴ Uredineae (rust fungi),⁵ and the three species of the recently described basidiomycetous yeast-genus *Sporobolomyces*;⁶ and it was therefore thought probable that these smut conidia, like the basidiospores just mentioned, are shot away from their sterigmata with the accompaniment of drop-excretion at the spore-hilum. The other author (T.C.V.) of the present communication undertook to test this supposition, with the result that, after overcoming the technical difficulties associated with (1) the germination of the chlamydospores in sterile 4 per cent. malt-agar and with (2) the development of the secondary conidia under conditions in which they could be watched for hours under the microscope, he made preparations which have enabled both of us to witness

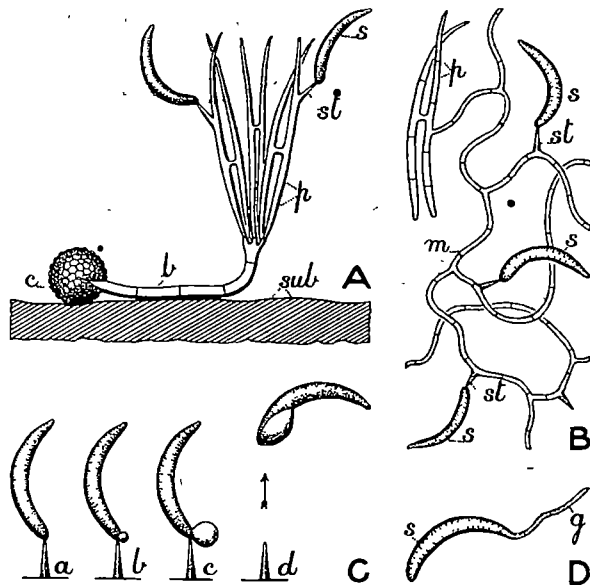


FIG. 1.—Diagrams illustrating spore-production in *Tilletia Tritici*. A: a chlamydospore *c*, with its basidium *b* crowned by six primary conidia *p* which have conjugated in pairs; two of the pairs have produced short sterigmata *st* terminated by sickle-shaped secondary conidia *s*, *sub*, a damp substratum. B: a pair of conjugated primary conidia *p* on malt-agar; their germ-tube has developed into a branched mycelium *m*, which at intervals sends up into the air short sterigmata *st*, which bear sickle-shaped secondary conidia *s*. C: stages in the discharge of a single secondary conidium; *a*, a full-grown spore on its sterigma; *b*, the same with a drop of fluid just appearing at the spore-hilum; *c*, the same, about 20 seconds later; *d*, the same, one second after *c*, the spore and the drop have been violently shot from the sterigma. D: a discharged secondary conidium *s*, which has fallen on malt-agar and has germinated; *g*, its germ-tube. Magnification: A and B, 300; C and D, 400.

the violent discharge of the secondary conidia, with the accompaniment of drop-excretion. Since 1883, the year in which Brefeld began to publish his classical researches on the smut fungi, many mycologists, phytopathologists, and general botanists have studied these organisms; but, hitherto, the fact that a smut fungus should display violence in the discharge of its spores has not been observed and does not even seem to have been suspected by any one.

A sickle-shaped spore, under laboratory conditions, takes about an hour and fifteen minutes to develop from a tiny rudiment to full size and to mature. At the end of this time, if all goes well, a tiny drop of fluid begins to appear on the spore-hilum at the base of the spore just above the sterigma (Fig. 1, C). The drop grows visibly, protruding laterally, and, in about 20

¹ Cf. F. L. Stevens, "Plant Disease Fungi," New York, 1925, p. 213.

² O. Brefeld, "Untersuchungen über Pilze," Heft 5, 1883, Taf. 12, Figs. 26 and 27.

³ F. Rawitscher, "Zur Sexualität der Brandpilze *Tilletia Tritici*," Ber. d. Deutsch. Bot. Ges., Bd. 32, 1914, p. 310.

⁴ Cf. A. H. R. Buller, "Researches on Fungi," London, vol. 3, 1924, Fig. 204, p. 505.

⁵ A. J. Kluyver und C. B. van Niel, "Über Spiegelbilder erzeugende Hefenarten und die neue Hefengattung *Sporobolomyces*," Centralb. f. Bakteriologie, Abt. 2, Bd. 63, 1924-1925, pp. 1-20, Taf. I and II.

seconds, attains a diameter equal to about one and one-half times the thickness of the spore. Then, suddenly, the spore and the drop are shot away from the sterigma to a distance of about one-half a millimetre. The sterigma left behind is apparently unchanged. Under suitable conditions, a thin spore-deposit of discharged spores gradually accumulates. On 4 per cent. malt-agar a spore begins to germinate within an hour of discharge from its sterigma (Fig. 1, D).

Sometimes abnormalities in spore-discharge may be observed. (1) A spore may grow to full size in the usual time, but there may be no drop-excretion at the hilum and no discharge. One spore remained seated on its sterigma unaltered for three days. (2) A spore may grow to full size and then, within an hour, may germinate at its apex. Such a spore never excretes a drop of fluid and is never violently discharged. (3) A spore may grow to full size and then, within an hour, a drop may be excreted at the spore-hilum; but the drop and spore are not discharged. Instead, the drop may run up the spore and then grow to an abnormally large size about the middle of the spore. The drop may dry up slowly and then the spore, while still seated on its sterigma, may germinate by sending out a germ-tube at its apex. The failure of the drop to be excreted and excessive drop-excretion, accompanied by failure of the spore to be discharged, as just described, have been observed by one of us as not infrequent abnormalities of the spore-discharge mechanism both in the Hymenomycetes and the Uredineæ.⁷ Also in *Puccinia graminis* the same author has observed that a basidiospore, which has failed to be shot away, often germinates *in situ* at its apex.⁸ Thus the abnormalities connected with the phenomenon of spore-discharge in the secondary conidia of our stinking smut fungus find their exact parallels in the abnormalities one may witness in a mushroom or in the fungus which causes the black stem rust disease of wheat.

Our discovery that the sickle-shaped spores or secondary conidia of Brefeld and others are violently shot away from their sterigmata, with accompanying drop-excretion at the spore-hilum, is of considerable theoretical importance; for it not only confirms with new and weighty evidence the correctness of the view generally held by botanists that the Tilletiaceæ belong to the great group of the Basidiomycetes, but it also allows us to draw the following new conclusions: (1) the so-called secondary conidia of *Tilletia Tritici* and of other species of *Tilletia* are in reality the true basidiospores; and (2) the sporidia or primary conidia of Brefeld and others are morphologically equivalent to sterigmata. Finally, it seems to us probable that further research will show that our new conception of the basidium in the genus *Tilletia* may be successfully applied to the basidia of the other genera of the Tilletiaceæ.

A. H. R. BULLER.
T. C. VANTERPOOL.

The University of Manitoba,
November 21.

Wireless Time Signals: Changes in the French Issues.

FOLLOWING a series of resolutions adopted at the meeting of the International Time Commission at Cambridge in July last, certain changes will be made in the issue of time signals from radio stations in France, commencing on January 1, 1926.

⁷ A. H. R. Buller, "Researches on Fungi," vol. 2, 1922, pp. 18, 308-310; vol. 3, 1924, pp. 500-509.
⁸ *Ibid.* vol. 3, Fig. 203, p. 503.

The present series of signals from the Eiffel Tower [FL], Lyons [Douai, YN] and Bordeaux [Lafayette, LY] will be withdrawn and will be replaced by the following series:

No.	G M T.	Signal	Station	W.L.	
1	8 0	International and Rhythmic Signals	FL	2,600	Spark
2	8.0	International and Rhythmic Signals	LY	19,000	CW
3	9 30	International	FL	2,600	Spark
4	20 0	International and Rhythmic Signals	LY	19,000	CW
5 6, 7	22 45	Old Semi-automatic Signal Short-wave emissions—see below.	FL	2,600	Spark

This series will be put into operation in the first instance for a period of four months, after which it is contemplated that No. 3 may be withdrawn and No. 5 replaced by an issue of the International and Rhythmic Signal from FL, simultaneously with that from LY at 20^h. By that time it is expected that the issue on spark from FL will be replaced by an issue on modulated CW.

In the meantime the issues Nos. 3 and 5 will take the same form as hitherto, and for ordinary users the only service which is withdrawn is the issue of the Old Semi-automatic Series from FL at 10^h 45^m.

The form taken by the issue No. 1 is the following:

- [a] Preliminary signal.
- [b] Times of issue of rhythmic signal of the *previous day* as determined by the *Bureau International de l'Heure*, Paris.¹
- [c] Commencing at 7^h 57^m 55^s, the International Signal as hitherto, except that the three dashes which have constituted the Time Signal are to be replaced by six dots, commencing at the seconds 55.0, 56.0, 57.0, 58.0, 59.0, 60.0 and lasting each about 0.2 sec.
- [d] Commencing at 8^h 1^m 0^s, a new rhythmic issue of 306 signals, falling as follows:

1 ^m 0 ^s ,	1st dash followed by 60 dots.
2 ^m 0 ^s , 62nd	" " "
3 ^m 0 ^s , 123rd	" " "
4 ^m 0 ^s , 184th	" " "
5 ^m 0 ^s , 245th	" " "
6 ^m 0 ^s , 306th	" " "

The commencements of all these signals are to be evenly spaced; the commencements of the dashes are intended to fall precisely at the commencements of the seconds of mean time and they will be each about one-half second in duration; the dots will be about one-fifth of a second in duration.

Besides these issues upon the wave-lengths hitherto employed by FL and LY respectively, issues Nos. 6 and 7 will be made at 8^h and at 20^h simultaneously with the other issues, by the station FL on *short wave-lengths*, namely, 32 metres and 75 metres, on the same pattern as the issues Nos. 1, 2 and 4 above, during the probationary period of four months. After that, it is contemplated that one or other of these wave-lengths may be suppressed and the other retained permanently in addition to the series [1]-[5] above.

A period of probation of four months has been adopted in order to ascertain how far the new issues meet both general and scientific requirements.

Any comments which are the result of experience on the working of the new issues, or upon the abolition of the old issues, should be addressed either to *M. le Directeur, Bureau International de l'Heure*,

¹ An intimation received since this circular was prepared places [d] subsequent to [d], commencing at 8^h 6^m 5^s or 20^h 6^m 5^s.

Observatoire National, Paris, XIV^e, or to the undersigned.

They should arrive not later than the beginning of March.

R. A. SAMPSON,
President, International Time Commission.
Royal Observatory, Edinburgh,
December 10.

Experiment and Philosophy.

THIS letter is a dogmatic rejoinder to nobody in particular.

There is a wise Scots saying which warns us against showing half-done things to "bairns and fules." It ought to hang as a text by the bedside of every scientific researcher, with a note appended that "bairns" is to be glossed "non-scientific thinkers and the educated public." The Great Educated Public thirsts, very properly, for knowledge; but it loves best, if it can, to get the wine of learning all raw from the presses, dispensed by the vintners themselves, and to suck it up through the sweet straw of analogy. Of late years there has been a remarkable indulgence of this crude taste for "the last word in science"; and one immediate result has been that a good many metaphysically-minded folk have hastily engorged certain possibilities, perceived and put forth by men of science to be further tested by men of science, but forming draughts too heady and unmaturing for the novice. Dazzling themselves with the tentative speculations of science, such pseudo-philosophers comfortably conclude—see them at it in any of the current reviews—that, after all, the scientific method can now be proved (with the aid of its own results!) to be merely argument in a circle.

So: all is well; the lamb of mysticism can now lie down with the lion of science, for the poor lion is exposed as nothing but a cud-chewing ruminant. Surely it is time that the lion gave a gentle roar or two, if only as a salutary reminder to the lamb who skips up bleating for more room than the lion is ready to concede?

The root of the trouble seems to lie in this: that non-scientific people are in such impetuous haste to "know" (as they are pleased to call the process of "being informed") that they will not understand the need to wait patiently for years—in large questions, for centuries—before suspicions now private to first-hand inquirers can be turned into public assertions. "Here's the latest," they seem to say; "let's have it; fling away what went before it and what went to make it." Yes; and fling away *this* latest, too, in a little while, so soon as real science shall have caught up with it and have made it a trifle dull and *démodé* because surer and better-balanced; and fling away, at the ghost of a permissive hint, whatever may any more obscure the glorious verities of untutored guessing. "How much better and finer it is (besides being much less trouble) to be able at last to ignore, as of old, the figments of science! (Of course, we don't mind using soap, we don't mind telephoning to our doctor to come quickly in his car to diagnose and cure our ailments, or to the surgeon to save our lives and minds—these scientific figments we tolerate, for we like them!)"

All this would not matter very much—the unlearned will perhaps know better in a few generations—if it were certain that it will not prejudice experimental science. But we buy a book purporting to teach the experimental man of science the inwardness of his business; we expect, perhaps, a helpful exposition of Whitehead's sane, lucid, and logical "Pan-physics," or else the elements of logical inference; but we get a

confounding blend of two or three universes of discourse, an ambitious and premature synthesis of the only partially-analysed, which leads the working human reader into a barren and impotent finality.

The motto of this journal, Wordsworth's sentence, surely abides, nor can it be wrested from its meaning by crying (with the materialists of last century) that Nature includes all mind. No experimenter holds, in his inmost soul, the converse; namely, that mind includes all Nature, has indeed created it; nor will he admit, for generations still to come, that our real knowledge yet suffices to probe the vast theorems that our hurrying philosophers broadly accept as already settled. Of those lugubrious thinkers, those reactionaries whose claim once again is *Totam Asiam peragraré*, and who seek to cast three hundred years of patiently-won lore into the melting-pot, to gain the Indies out of the crucible: of these none are experimenters. They are like the jaded urban hero in the story, whose regeneration depends on his coming "close to the green and growing earth"; they have attenuated honest sense-facts by unremitting abstractions to the *n*th degree; they have lost the last touch with reality.

The working man of science at least has his feet well planted in the solid ground of observation; and if the soaring philosophers accuse him, on the contrary, of having his head too tightly embedded in that same ground, let him at all events show them that his protruding extremities nevertheless have not lost the power of vigorously kicking.

THOMAS HOBBES, Junior.

A *pp'* Group in the Arc Spectrum of Zinc.

ONE of us (R. A. S.) in a study of *pp'* groups in atomic spectra, which will be published in full later, has observed that in many two-valence-system spectra the frequency of the first *pp'* group is nearly a mean between the frequency of the first line of the principal series of singlets in the spectrum and the first line of the principal series of doublets of the once more ionised atom.

The rule holds for the *pp'* group in cadmium given by Ruark (*J.O.S.A.*, vol. 11, 1925, pp. 199) where we have

Cd I, 1S	-2P	$\nu = 43691$
Cd I, 2p ₁	-2p ₁ '	$\nu = 44088$
Cd II, 1s	-2p ₁	$\nu = 46618$

We were accordingly led to apply this rule to zinc where an exactly analogous group to that in cadmium was easily located.

The complete cadmium group as given by Ruark is:

λ .	Int.	ν	Classification.
2329.27	10R	42918.6	$2p_2 - 2p_1'$
2306.61	5R	43340.3	$2p_1 - 2p_0'$
2267.46	5R	44088.6	$2p_1 - 2p_1'$
2239.86	5R	44631.7	$2p_0 - 2p_1'$
$\Delta p_1 p_2 = 1170.1$, $\Delta p_0 p_1 = 543.1$			
$2p_1' = -2206.6 \text{ cm.}^{-1}$			

The group is anomalous in that only four lines appear instead of six lines as in a normal *pp'* multiplet, but the classification is fixed by the known Zeeman pattern of the line $2p_1 - 2p_0'$.

In zinc we find a similar group of four lines which we have classified as follows. The wave-lengths of Eder are used.

λ .	Int.	ν	Classification.
2104.34	2	47505.7	$2p_2 - 2p_1'$
2096.88	2	47674.7	$2p_1 - 2p_0'$
2087.27	2	47894.0	$2p_1 - 2p_1'$
2079.10	2	48082.2	$2p_0 - 2p_1'$
$\Delta p_1 p_2 = 388.3$, $\Delta p_0 p_1 = 188.2$			
$2p_1' = -4629 \text{ cm.}^{-1}$			

This group obeys the rule stated in the first paragraph as follows:

Zn I, $1S - 2P$	$\nu = 46745.8$
Zn I, $2p_1 - 2p_1'$	$\nu = 47894.0$
Zn II, $1s - 2p_1$	$\nu = 49354.7$

It also has within reasonable limits the separations of the known $2p$ levels of zinc which are:

$$\Delta p_1 p_2 = 388.9, \Delta p_0 p_1 = 189.8.$$

The Zeeman pattern of none of these lines is available so far as we can find.

We have been permitted to examine these lines on a spectrogram taken with a Hilger E 1 quartz spectrograph by Dr. R. V. Zumstein, National Research Fellow, at the University of Michigan. All four lines are sharp and like in appearance, although $\lambda 2087$ appears to have a close diffuse companion barely resolved from it on the short wave-length side. There is a fifth line which might conceivably belong to the group, although its diffuse character would seem to exclude it. This line is

$$\lambda 2070.11 \quad \text{Int. I} \quad \nu 48291.2$$

If this line were classified as $2p_1 - 2p_2'$ and the short wave-length companion of $\lambda 2087$ classified as $2p_2 - 2p_2'$, we should then have a normal pp' triplet group. In view of the fact that $\lambda 2070$ is diffuse and quite different in appearance from the first four lines, we hesitate to make this assignment. It may be said in favour of it that the diffuse companion to $\lambda 2087$ mentioned above might be interpreted to mean that p_2' has a diffuse nature. We know, however, of no similar example of this sort.

RALPH A. SAWYER,
NORMAN C. BEESE,

Physical Laboratory,
University of Michigan,
Ann Arbor, Michigan,
November 6.

On a New Device for the Study of the Compton Effect.

ACCORDING to a recent tentative suggestion of W. R. Smythe, a study of the intensities of the Compton modified scattered X-ray spectrum lines might serve to prove whether the electrons effective in the scattering which produces the modified radiation are completely "free" or whether they are "bound" to atoms of the scattering substance. If "modified" scattering is produced by free electrons only, then the intensity of the modified line should be jointly proportional to the intensity of the incident radiation (number density of radiant corpuscles) and to the number of free electrons present. But this latter is itself at least roughly proportional to the intensity of the incident radiation, since it is safe to assume that most of these free electrons are rendered so by the photoelectric action of the incident X-radiation. Hence the intensity of the modified scattered line should vary roughly as the square of the incident intensity, or at least as some greater power than unity of the incident intensity.

Up to the present date, so far as I am aware, it has been necessary to study the Compton effect by very greatly prolonged X-ray exposures, or by ionisation chamber methods requiring extremely powerful X-ray tubes for the incident intensity, and very sensitive electrometer methods for detecting the presence of the lines. This is largely due to the fact that the original radiation must be scattered twice in succession, once to obtain the effect and once at an analysing crystal. The photographic exposures are frequently

prolonged to 100 or 200 hours' duration and occupy a good portion of the life of an X-ray tube.

In order to investigate Smythe's suggestion, and for other purposes, I have constructed an X-ray tube of special design in which both scattering substance and analysing crystal are contained in a small metal box mounted on the end of the anti-cathode. The distance from the source of primary X-rays to the scattering material is so greatly reduced that the radiation available for the scattering is of the order of two thousand times more intense than that heretofore available. *It has been found possible to produce photographic spectrograms of the Compton effect with this apparatus in thirty seconds that would by previous methods have required a hundred hours' exposure.* Very moderate currents such as 5 ma. suffice for exciting the primary X-radiation. The possibilities of such an apparatus for high dispersion studies and many other purposes will be immediately evident to any one familiar with this field of work.

Preliminary studies with the new "target spectrometer" seem to show very little evidence for any intensification of the Compton modified lines greater than a strict proportionality to the incident intensity would require. It is too early, however, to decide this question with precision. If Smythe's tentative prediction is not eventually supported by experiment, then the theory that bound electrons are responsible for the observed "softening" of X-radiation scattered by light elements is strengthened.

Work is now in progress with the new apparatus which I hope will decide the above-mentioned question. A study of the fine structure of modified and unmodified lines by means of the new instrument is also under way. One of the novel features of the present target spectrometer is that it permits the study of radiation that has been scattered at an angle of almost exactly 180° . This angle offers several advantages in the study of the fine structure of the modified line.

JESSE W. M. DUMOND.

Norman Bridge Laboratory of Physics,
California Institute of Technology,
Pasadena, California,
October 28.

Genes and Linkage Groups in Genetics.

I WOULD like to ask Prof. MacBride to clear up one point in his review in NATURE for November 28, p. 776, for otherwise those who are not geneticists may be led astray.

Prof. MacBride writes of "the crude conception of the linear arrangement of the genes in the chromosome, and the idea of crossing-over." He is here, however, confusing two distinct points: (1) the linear arrangement of genes within linkage-groups, and the phenomena of partial linkage; and (2) the identification of the linkage-groups with the chromosomes. Even if the latter were disproved, the evidence for the former would remain in its entirety, and it is with this alone that I wish here to deal.

Mendelian differences do occur; some genetic bases for them exist ('genes'); genetic research, starting from Bateson's fundamental work on coupling and repulsion ('linkage') has shown that they exist in groups, and that within each group they are in orderly arrangement; and finally, Jennings has shown mathematically that a linear arrangement is the only one so far proposed which will fit the genetical results.

These seem to most biologists to be important facts; and if Prof. MacBride will admit them, I should feel that there was a common basis for discussion. He does go on to discuss 'linkage,' but it is not clear to

me what exactly he intends. If there be any other explanation of the genetical linkage-results than what, following Morgan, I have given above, it is important that it should be fully and clearly set before us

JULIAN S. HUXLEY.

King's College,
Strand, W.C.2.

THE confusion is in Prof. Huxley's mind and not in mine.

Of course, I recognise that there are such things as 'linkage groups' and that these must have some basis, but what that basis was I thought that I had made clear in my review. It is, I believe, an impairment of what for want of a better name may be called the 'developmental energy' of the organism which leads to an inhibition or slowing down of one or more of the independent processes of growth which make up its development.

The so-called 'genes,' 'unit factors,' or 'mutations' that are linked are so many symptoms or results of this weakening. According to its intensity, more or fewer of them may make their appearance, hence the variable character of the linking. The alleged 'orderly arrangement' of genes within each group is in my opinion a figment of the imagination to which, so far as I am aware, Dr. Bateson has never committed himself.

Jenning's 'proof' that the linear arrangement of the genes is the only one mathematically possible is, like so many examples of 'proofs' given by this school, a fine example of reasoning in a circle, for it assumes the breaking of the chromosome and the 'crossing over' of its pieces, which, as I have shown in the review, is a physical absurdity. I am confident that when the same physiological analysis is applied to the development of *Drosophila* which has been employed in the case of *Vertebrata*, its many mutations will be seen to be the multiform effects of a few simple causes, and I should like to remind Prof. Huxley that Johannsen, perhaps our foremost geneticist, has expressed a desire that the term 'unit-factor' should be proscribed, for the change to which we give this name is merely, he says, a "disturbance of the chromosomes." With this opinion I cordially agree.

E. W. MACBRIDE.

Moulting of Insects.

THE usual explanation of moulting, namely, that the chitinous integument, being elastic only to a limited extent, cannot keep pace with the increase in size of a growing insect and is therefore periodically shed, does not seem to have a very strong foundation. While experimenting upon the effect of starvation on insects, I have incidentally observed the following facts which strongly tell against such an explanation:

As is now well known, the usual length of the larval stage in *Tenebrio molitor* (the common meal-worm) is 7-8 months, during which they moult 14-15 times. When the worms were intermittently starved, the larval period was extended to so many as 18 months, during which they moulted 30-31 times. The interesting point to be noted is that the size and weight before pupation of the 18 months' old larvæ (starved) and of the normally fed 7-8 months' old worms were the same. Since the ultimate size and weight remain the same, then, if moulting is simply to allow growth, there is absolutely no necessity for extra moults. Moreover, in one experiment, in which the worms were completely starved for 5 months and were actually losing weight and shrinking in size, the larvæ moulted 4 times, though, of course, this

number was smaller than that in the normally fed individuals.

A similar state of things was observed in *Pieris brassicae*. In this species the larval stage extends over about 3 weeks in Great Britain (August). Starved caterpillars, which pupated about one month later than control individuals, moulted five times instead of four times, as is usual for this species and as was done by the normally fed individuals. The size and weight of both the starved and the control caterpillars just before pupation was almost the same.

Evidently, moulting cannot be solely and possibly is not mainly correlated with growth, because while growth does not exhibit itself unless there is a moult, the process of moulting can occur without being followed by growth. F. Balfour Browne, while rearing dragonflies, also observed that while some moults were followed by an increase in size, in the case of others the individual did not show any such increase (*Proc. Zool. Soc.*, 1909). That the number of moults is in proportion to the length of the larval life is better explained by considering that moulting is primarily connected with metabolism. Totally starved meal-worms moult less frequently than normally fed individuals, because their metabolism is at a low ebb.

HEM SINGH PRUTHI.

Zoological Laboratory,
Cambridge,
December 2.

Rate of Growth of Fungus Rings.

IT is well known that on air-photographs of the chalk downland, fungus rings are often very clearly shown. Sometimes they form the most prominent objects on the photograph and their size is considerable. It has been noticed that they are best developed upon land which has not been under plough for a very long time: in fact they seem never to occur well developed on land which has been ploughed at some time during the last century or two and afterwards reverted to grass.

Before investigating this matter further on the air-photographs here, I should be grateful for information as to the rate of growth of these rings. Is it possible to tell the age of a ring from its diameter? I would gladly lend prints showing fungus rings to any one who is interested in this branch of study and might be able to supply reliable information on the subject.

O. G. S. CRAWFORD.

Ordnance Survey Office,
Southampton,
November 18

Einstein Shift and Doppler Shift.

MAY I ask whether the Einstein shift of spectral lines is supposed to be due to some change of frequency associated with an atomic occurrence while generating waves, or to direct influence of the gravitational potential on ether vibrations after they are generated.

For example, I suppose the observed shift in light from the companion of Sirius occurs in light primarily emitted, and not merely scattered, from that star. The light from a differentially moving dark satellite would exhibit to us a differential Doppler effect, but the satellite would presumably not affect the light borrowed from its primary with an Einstein shift, however concentratedly massive it might be.

I am not sure that this is correct: hence my question.

OLIVER LODGE.

December 8.

Evolution.¹

By Sir OLIVER LODGE, F.R.S.

THE word "evolution" is often employed as an antithesis or opposition idea to creation; and it is quite possible that when Herbert Spencer was trying to extend ideas derived from Darwin as to the natural processes by which species had originated, and to apply them to the production of everything, that some idea of that kind was in his mind. He probably felt that he was exploding the popular idea of a sudden creation, a sudden production of things by a creative fiat, and substituting a long, slow, and gradual process, by which the simple evolved into the complex, and the potentialities latent in the atoms of matter became unfolded, developed, evolved; thus substituting or replacing a personal process, guided by something like will and intention, by an atomic and, so to speak, mechanical operation among the things themselves.

How mind and consciousness could come into such a scheme was scarcely known, though there were and had been guesses about that too; and the doctrines called "parallelism" and "epiphenomenalism" were sustained by different philosophic writers. Indeed, how life, even of the lower organisms, originated, was never answered; and though many attempts were made, all over the world and for centuries, at spontaneous generation (some of them in late years by Charlton Bastian at King's College, London), they never succeeded in producing life except by faulty experimentation. It was gradually established, and accepted by Huxley, that life only proceeded from antecedent life, so far as our experience went: that if all vital germs were excluded, no life, even of the lowest kind, appeared.

It was research on these lines which summoned the great Pasteur from chemistry to biology. It laid the foundation for his theory of disease, and it was the noble work of Lister to apply it with beneficent results to surgery. Thus and by all these channels was emphasised the doctrine of biogenesis: that life alone could produce life. Life produced itself; still, however, in its various forms, by a process of evolution, and by no act of special creation. The vital steps were gradual and could all be followed, once given the germ of life. The origin of life itself was left as an insoluble mystery, or rather as a mystery to be solved by science at some future date. It was thought, at any rate by some, that once life made its appearance in the scheme, the evolution of mind was only a further step in the process. Mind was apparently a stage ahead to which life might aspire, for life in the course of ages might blossom into mind.

The attempt thus to explain evolution as a gradual self-acting process was a legitimate one, and contained, as we now see, many of the elements of truth. It led to a materialistic philosophy, which for a time held the field, and attracted the attention and the enthusiasm of a multitude of workers. It was, however, not the whole truth: it was a working hypothesis. It went a certain distance with success, and only gradually were its weaknesses perceived. It was not so much wrong as incomplete. It sought to account for things it could not account for. But as an intermediate step it was

helpful and stimulating, and invigorated the science of biology with a working hypothesis which has proved of great service. It served as a clue or guiding light among a multiplicity of phenomena which without it had seemed detached and disconnected; and it stimulated observation and experiment to a remarkable degree. It carried workers a long way, and it carried enthusiasts too far. It led to the exclusion of mind or purpose from the universe, and replaced it by mechanism. If a materialistic philosophy had worked, it would have been justified by results. But it was incomplete; and gradually its weaknesses and omissions became apparent; so that by this time, as a complete account of the universe, it is recognised as insufficient and faulty. The mistake—if it can be called a mistake—lay in the thoughts or contentions of those who put it forward as in opposition to the idea of creation, instead of regarding it as a method of creation.

The old idea of creation as a sudden achievement without intermediate steps, without any process that could be followed by the human mind, and without any extensive lapse of time, was seen to be erroneous. Yet, amid much crudity, most of us now perceive that it contains some elements of truth; just as the working hypothesis of mechanical evolution did. The time was not yet ripe for identifying and unifying the two. They seemed to be in the field as opposition theories, one against the other. They seemed to be mutually exclusive; so that if one were accepted, the other must be rejected.

Whether this opposition of the two views was seriously in the mind of the philosophers of that period may perhaps be questioned; in all probability it sometimes was. Among the rank and file it certainly was: many half-educated people leapt to the conclusion that the universe could be explained on mechanical principles and in terms of matter, and that in matter could be found the full potentiality of life and mind and everything that we have so far discovered or experienced in the universe. Whether or not that was the intention of the leaders may well be doubted. Huxley himself made it abundantly clear that in his view a materialistic philosophy had its limits, and that consciousness could not thus be accounted for. Nevertheless the two views, in the popular mind, were in opposition; and it led to alarm among the Churches at the doctrines of Darwinism and at the teachings of evolution generally. This feeling of antagonism between the two views, and the feeling of alarm and dislike of one of them, has survived in certain States of America, and has led to an attempt to suppress the disliked view by legal enactment.

However irrational this procedure may be, there is some excuse for it; and it is possible to regard their conscientious action with sympathy, even though the sympathy is mingled with amusement. Not in that way is truth really served. Freedom is the life-blood of science; and freedom is only consistent with the power of making mistakes and going wrong, as well as with the power of ascertaining truth and going right.

Crudities were not confined to one side of the controversy. Old doctrines of creation were crude; new doctrines of evolution were equally crude: and either

¹ From the Huxley Lecture delivered at Charing Cross Hospital on Thursday, December 3.

side could have their teeth set on edge by the other. Young and enthusiastic teachers, perceiving only one side of the problem, could rush into extremes; could not only uphold their own view, but also could pour scorn upon the other. Since the sectarian differences between religious bodies had led to the suppression of what may be called Biblical teaching in State schools, as the only alternative to strife and sectarian controversy,—since the freedom of the orthodox was limited, and they were prevented from teaching the young their own special and detailed creeds,—it became obnoxious to allow perfect freedom to the opposition side, which took no interest in sectarian controversy, but would gladly sweep away the whole of the doctrines associated in the popular mind with the mysteries of religion. Sectarian differences had limited freedom on one side; it seemed time to limit freedom on the other too; and that, I take it, is the explanation of what otherwise seems an irrational and foolish procedure.

There are, I know, a multitude of people in Great Britain who still feel the fundamental opposition between the two views, and some who in their heart sympathise with the action of those Southern States who have put the law in operation against one of them. There is always some justification for any human action which is well intentioned and sincere, however mistaken it may be. We are all of us constantly making mistakes: the proverb says that "it is human to err." It is part of our training to be able to make mistakes with perfectly good intentions, one of the mistakes being to think that we have an infallible guide when we have not. Infallibility has not been granted to man. We have to make our way among pitfalls and obstacles, to make progress slowly and with difficulty, and gradually to learn what is true by finding what is false; never learning the whole truth—for that we could not apprehend—but making our way towards the truth, in a blundering but persevering manner.

The very documents to which some of the ultra-orthodox pin their faith are full of misstatements and errors committed by humanity in the past; and however full they are of inspiration—as in many parts I am sure they are; much more, as I think, than some educated people are always inclined to admit—yet they are human documents, full likewise of the mistakes, misinterpretations, slips and errors appropriate to the human vehicles through which they have come. It is our business to try to sift the true from the false, the genuine from the mistaken, the misinterpretations of scribes, the faulty reports of occurrences, and thus to dig down to the underlying essence, which gives these documents their supreme value.

The book of inspiration, by which I mean the thoughts of the great thinkers and seers and saints and prophets of all time, is one avenue of truth: the book of Nature, explored by a multitude of energetic workers, that is to say, the book of science, is another. In so far as both are true, they cannot be in opposition. In so far as either is mistaken, opposition is inevitable; and although the virulence of the opposition is now greatly mitigated, and is not fierce and uncompromising, as it was even in the lifetime of some of us, some amount of opposition exists still. Indeed, in the minds of half-educated people its virulence is still manifest, and some fierceness of opposition still subsists to this

day. It is so easy to take one side only of a controversy, to regard that as completely right, and the other as hopelessly and completely wrong. We find this attitude even in party politics. We find it more or less in the forensic activities of counsel in the law courts. It is understood, there, as a method of laying the case before the judge, to whom is left the impartiality of scrutinising the evidence for what it is worth, and coming to a judicial and balanced decision.

We ourselves, however, in our own minds and with our own responsibility, are both counsel and judge. There are moods in which we emphasise one side; there are moods in which we emphasise the other: but ultimately we try to hold a balance between them, and we doubtless hope that our ultimate convictions will be based on the evidence, and will lead to a true and impartial verdict.

My thesis is that there is no essential opposition between creation and evolution. One is the method of the other. They are not two processes, they are one—a gradual one which can be partially and reverently followed by the human mind. We have the right to study the methods so far as we can, the right to probe into the manner by which the manifold things around us are interrelated, and how they have come into their present form. We try to set forth the physical processes in detail, and for that special purpose to limit ourselves to the mechanical, the physical, the chemical, the calculable, and the directly observed, without the least trace of impiety, and without being reasonably accused of denying a great tract of country which is not on our beat, which we are not exploring, and which, though through lack of time and energy we perforce neglect, we do not (if we are wise) ever think of denying.

[Then followed an account of the process of cosmic evolution so far as modern science is able to formulate it, based upon the work of Eddington and Jeans. The question was then raised as to whether a linear process of evolution—a procedure in time with a beginning and an end—was likely to be the last word, or whether there was any way of overcoming the dissipation of energy and prospective stagnation.]

Now consider what happens when light of all kinds, ultra-violet light, X-rays, and all others, encounters a particle of dust, or, in other words, some atoms of matter, which have been driven to the confines of space by the pressure of light. What happens has been investigated in our laboratories, and is known as photo-electricity. An electron jumps out of the atom: the atom is ionised.

This ionisation of matter by light is becoming, or is likely to become, familiar in medicine. The photographic and chemical actions of light are constantly being studied, its action in polymerising sap in the leaves of trees and vegetation generally, the action of light on the skin also, and its familiar though remarkable effect on the nerve-supplied retina of the eye. How are these chemico-physical actions to be accounted for? Surely by the photo-electric property; that is, by the power of waves of the right frequency of vibration to eject an electron from an atom. An immense amount is now known about this process. Electrons are

revolving in fixed orbits inside the atom, as conceived by Prof. Bohr, and under the stimulus of radiation they jump from orbit to orbit as birds jump from perch to perch. An incoming wave can make them hop to a higher twig, or else fly away altogether.

This last process is called ionisation; for the atom, having lost an electric charge of one sign, is now charged with the opposite sign: it is an ion; it is no longer neutral and inert, it is active and chemically fierce; it is no longer satisfied, it seeks to combine with another. Chemical affinity is in full blast, and the molecular changes in protoplasm, in silver salts, and in the leaves of trees, occur. In the retina the nerves are bombarded by the ejected electrons, each striking with an energy appropriate to the frequency of the received vibrations, and thus give the different colour sensations through the extraordinary interpretative power of the mind through its organ the brain.

The destructive influence of this action on micro-organisms such as an anthrax bacilli, when they are exposed to ultra-violet light, is well known; and the health-giving power of these same ultra-violet rays—at present so sadly and wastefully and thoughtlessly obscured by the atmosphere of towns—is constantly receiving more and more expert attention.

Surely here we have a region of physics of great use in preventive medicine: a lavish supply of ultra-violet light is sent us by the sun; it only remains for us to enable this light to reach our bodies and our homes. We know how to generate such radiation in the laboratory also, and can use these rays for curative rather than for preventive purposes. A study of radiation—radiation of all kinds—has proved of late years intensely illuminating. Thereby that mysterious but fundamental entity, the quantum, has been detected; thereby the temperature, the constitution, the age, the speed, the history, of the various cosmic masses has been and is being elucidated; thereby the formation of wood, and the growth of vegetation on which animal life depends, has been explained; and now the sanitary and invigorating and beneficent work of sunlight on the human organism is being more and more appreciated, and more and more studied and applied by those who have the requisite training, who will watch for the dangers of excess, and regulate the appreciation of any kind of ray with patience and wisdom. I hope that a recognition of the electric and ionising power of such rays, which I urge as a reasonable explanation of their chemical and physiological activities, may be a hint in the right direction to those engaged in this work.

Reverting now to what I was beginning to deal with, namely, the hypothetical effect of stray or apparently waste radiation when it reaches the confines of space and encounters the supposed age-long accumulation of cosmic dust, which pictorially and for the present purpose we represent as more localised than it is at all likely to be; it may be said that the light, when it has travelled to those enormous distances, will be too feeble to do anything; but apparently it is not so. The jump of the electron is effected, not by the energy of the light, but by its frequency, its rapidity of vibration; and that is just the characteristic which it will retain unaltered, no matter how far it goes, or how weak it gets. Light of the critical frequency—which depends on the nature of the atom and the position of

the electron in it—will be able to ionise it, however impoverished by wide-spreading the light is.

It is true that the number of electrons liberated depends on the intensity of the light, though the energy of each does not so depend. If the light is very weak, the number of ions formed will be few, but the area available is enormous. Nothing like such an area of matter exists in the visible cosmos. If only one or two ions a second were formed per square kilometre, the loss of matter from millions or even billions of suns could be compensated.

Now consider what happens when an atom is ionised. It has lost a negative charge: it has therefore become a positive ion. The negative-charge has gone away, and will attach itself to some other atom, which thereby becomes a negative ion. Sooner or later the two may meet. They will not discharge into each other; that is not what happens; they will combine to form a molecule, a chemical compound. The process of chemistry has begun; under the influence of light.

We are evidently returning to the stage at which we begin the consideration of the course of evolution. Radiation gives up its own being, the energy takes the form of electrical separation. It then takes the form of chemical combination: aggregates of matter are formed. This aggregation may go on until the particles begin to feel the effect of the gravitative attraction of the far-distant cosmos. No longer will the particles be sustained and separated and driven away by light. They are now big enough to have effective weight; and slowly they will begin to make their way back; bringing with them in potential form the lost and radiated energy; and so begin once more the clash of atoms, the formation of nebulae, the birth of stars, and ultimately of planets.

It may even be that fresh matter in the form of electrons and protons can be *generated* by radiation, apart from its photo-electric effect on already existing matter. To me it seems not unlikely. But that is going outside our laboratory knowledge: of that process of "beknotting" in the ether we have as yet no inkling. A knowledge of that may come, but not yet. Meanwhile we have something which, if not sufficient, seems at any rate a step towards reconstruction, rehabilitation, regeneration.

Some may feel this doctrine depressing, and ask: Is there then no progress, no increase of value, no real improvement, nothing but a universal level of uniformity, so that what is always has been and always will be, not only without change and decay, but also without rise and advance? That is not the deduction that we are entitled to make. For remember that we have been dealing with the physical universe only; we have not touched on the universe of mind, soul, spirit, or any of the emotions and faculties of man. We have been studying the course of physical evolution, and have imagined it as evolving in a cycle. I believe that is the essence of the physical universe, to follow a cycle, round and round:—The plant assimilating inorganic materials, elaborating them into food for animals, the animals returning them in the inorganic form, ready for the plant; energy taking the potential form, then the kinetic, then the potential again, and so on alternately for ever; water evaporated, rising as vapour, then falling as rain, getting back into the sea, and being

evaporated again. Everywhere we find a cyclical process in the material universe.

What about the mental universe? Surely there we find growth, development, increase of value, rise in status; the lower organisms becoming intelligent creatures, then developing into man. And what of man? If his death is the end of him, the value of his existence may be doubtful. But if, as I know, that is not the end of him, then there may be infinite progress in store. The cyclical machinery of the physical universe is employed to develop value in the mental and spiritual universe; just as the revolution of a fly-wheel may be the means of turning out a woven fabric

of beauty and design. The fabric will age and turn to dust: so may a picture or a statue. But what about a poem or a piece of music? They have in them the seeds of immortality, and if great enough, will last so long as humanity endures. All things last for ever, if what we have been saying is true; but while the physical things last by a kind of evolution of cyclical change, the evolution of spiritual things has no necessary regress. They advance continually through higher and higher stages towards perfection. This, I take it, is the real meaning of evolution. This is why the physical universe exists. This is the real aim and purpose of the ultimate and infinite term "God."

Surveys of the Great Pyramids.¹

By Sir W. M. FLINDERS PETRIE, F.R.S.

THERE seems a periodicity in the attention to the size of the Great Pyramid: the French survey 1799, Howard Vyse 1838, my survey 1881, and now Mr. Cole's survey in 1925, are at nearly equal intervals. The difficulty in measurement results from the Arab destruction of nearly the whole of the fine sloping blocks of casing, about 3 feet thick, thus leaving the inner core of masonry in steps, and further, the banking of the ruins up to 20 or 30 feet against the faces, which obstructs the base. The last remains of the lowest course of casing are only a short length in the middle of each side, and the purpose of this recent survey was to utilise more of these points of the original casing than had been seen before, such being more accessible since the removal of large quantities of the fragments, for making the road and building an hotel. In 1881 it was a risky affair to sink pits in loose rubbish 20 feet deep; I only escaped burial by a few seconds; seventeen shafts were sunk, but the casing edge was only found once on each side. In 1925 it was possible to uncover the casing over lengths of between 45 and 170 feet on different sides, and the use of such further material was very desirable in order to define the faces more precisely.

The 1925 survey was in two parts: (1) the prolongation of the alignment of the remaining portions of casing out to the corners by theodolite sighting, and (2) the survey of these produced corners by triangulation. The general order of accuracy that should be sought is indicated by the levels of the pavement, of which the mean error is only 0.21 inch; certainly it would be easier to achieve equality of length than of level. The method of setting a theodolite over an estimated edge of sloping casing, and then of telescopic estimation of such an edge at more than 100 feet away, is a risky process on the sand-blasted, pitted and chipped surfaces. The differences between 1881 and 1925 surveys depend on a third of an inch in such estimations. After that, the results depend on the 1925 triangulation for fixing the corner intersections by a chain of eight points joined by a traverse around the pyramid; this had a difference of 9.6" = 2.7 inches if on the whole distance, which was distributed equally in the reduction. The 1881 survey included the whole pyramid in a single triangle, the discrepancies of which averaged

0.04 inch; these station marks can always be re-used, as they were drilled in the rock, and the co-ordinates were all published.

The results of the two surveys are, in inches of length of the side and angular orientation of face:

	1881.	1925
N. side	9069.4 - 3' 20"	9065.1 - 2' 23"
E. side	9067.7 - 3' 57"	9073.0 - 5' 30"
S. side	9069.5 - 3' 41"	9070.5 - 1' 57"
W. side	9068.6 - 3' 54"	9069.2 - 2' 30"
Mean	9068.8 - 3' 43"	9069.4 - 3' 6"
Mean differences	0.7 12	2.3 12

There is a check on the estimated prolongation of the sides in 1925, as there is the 1881 estimate of the planes touching the core masonry. These were:

	1881.	Difference to Casing 1881.	Casing 1925.
N.	9002.3 - 4' 35"	+1' 15"	+2' 7"
E.	8999.4 - 5' 26"	+1' 29"	- 4
S.	9001.7 - 5' 23"	+1' 42"	+3' 26"
W.	9002.5 - 5' 39"	+1' 45"	+3' 9"
Mean	9001.5 - 5' 16"	+1' 33"	+2' 10"
Mean differences	1.0 20	1.0	1 8

As the planes of the core could be estimated within an inch of variation (=23") this is a useful check. It shows that the casing was adjusted 1' or 2' differently after the core was built. The divergence of the 1881 casing lines from the core have only 10" irregularity; the 1925 results show 1' 8" of irregularity; as this latter is equal to 3 inches on the length of the side, the core is competent evidence in favour of the 1881 survey. It may also be observed that a building with mean error in level of 0.2 inch is more likely to have a lineal error of 0.7 inch found in 1881 than of 2.3 inch found in 1925.

On all grounds it seems highly desirable to settle more precisely the exactitude of the most accurate human work of such large size. Station marks are needed at the side of each end of the lines of casing observed, to be connected with the more accurate triangulation of the 1881 net, which has less than 0.1 inch probable error in stations. Offsets should be taken between the new stations to the estimated edge of the casing all along. These would show how exactly the straightness was maintained, on which depends all evidence for prolongation of the short lengths of remaining casing.

¹ "Determination of the Exact Size and Orientation of the Great Pyramid of Giza." By J. H. Cole. (Survey of Egypt, Paper No. 39, Government Press, Cairo.) 1925. 8vo. 9 pp. 1 pl. 10 P.T. (2s 1d).

The bases of some of the other pyramids are also known from my surveys. That of King Sneferu at Meydum immediately preceded the Great Pyramid, and was planned on a similar system of measures. Both have the proportion resulting from the height being the radius of a circle equal to the circuit of the base, the angles found being

By π theory	51° 51' 14" 3
Khufu's pyramid	51 50 40 $\pm 1' 5''$
Sneferu's pyramid	51 52 $\pm 2' ?$

The dimensions found are:

Khufu's, height 7, circuit 44, $\times 40$ cubits.
Sneferu's, " 7, " 44, $\times 25$ cubits.

The modulus of design being thus 40 or 25 cubits shows the deliberate intention to embody the proportion of 7:22. The cubit required would be 20.61 or 20.66 respectively, and the best examples of early masonry elsewhere show a cubit between 20.62 and 20.65 inches. The mass of theories, which extend from good reason into a morass of impossibilities, would be too much to touch on here.

The accuracy of construction of the measured pyramids is, in inches:

Dynasty.	King.	Place.	Base.	m.d.	Azim.	m.d.
III	Sneferu	Meydum	5682 0	6.3	-24' 25"	5' 30"
IV	Khufu	Gizah	9068 8	7	-3' 43"	12
IV	Khafra	"	8474.9	1.5	-5' 26"	33
IV	Menkaura	"	4153.6	3.0	+14' 3"	1 50
XII	Senuser II.	Lahun	4168.5	1.9	-2' 8"	2 30
?	?	S. Dahshur	7439 0	3.7	-9' 12"	4 3
			2064.6	1.1	-14' 8"	10 12

From these measures it seems that Menkaura and Senusert II. laid out 200 cubits as a base, and the South Dahshur pyramids are of 360 and 100 cubits on each side.

In the XIIth dynasty the passion for accuracy led to regarding that as the finest sacrifice in honour of the dead; the granite sarcophagi, which were never intended to be open to examination, or even seen, have mean errors from a straight line, and from true planes, of 1 in 15,000, or on one edge 1 in 23,000. No race ever seems to have appreciated so keenly the charm of perfection of work as did the magnificent men of the pyramid age.

Current Topics and Events.

IN a recent series of papers in the *Chemical News* (Oct. 30, Nov. 6, 13, 20 and 27) Messrs. Druce and Loring put forward claims that they have identified the elements of atomic number 75, 85, 87 and 93 by an X-ray examination of certain manganese salts. The element 75 is that recently isolated by Noddack and Tacke (rhenium), the others are in the radioactive region. An examination of the evidence on which these claims are based suggests that it is far from sufficient definitely to establish them. The element 75 is identified by two lines, 1.430 and 1.233, which are taken to be the α_1 and β_1 lines of its L spectrum; 85 by two lines, 1.086 and 0.895; 87 by a single line 1.040, and 93 by two lines, 0.895 and 0.693, the 0.895 line being the same as that used for the identification of the element 85. Of these six lines four, 1.430, 1.233, 1.040 and 0.895, are within error limit identical with the $K\alpha$ line of zinc and the three strongest lines (α_1 , β_1 , γ_1) of the mercury L spectrum. The authors quote a control experiment in which a six hours' exposure with a copper anticathode gave only the copper spectrum. This is rather surprising, as mercury is used to evacuate the tube and brass for the window of the tube and the slits of the spectrometer. Also, in a recent experiment made elsewhere and suggested by past experience, a two hours' exposure with a copper anticathode and apparatus similar to that used by the authors gave, in addition to the copper lines and the silver and bromine absorption bands, lines which were identified with the zinc $K\alpha$, the mercury $L\alpha_1$, $L\beta_1$, and $L\gamma$ (?), and other lines at 0.950, 0.72 and 0.67. These are of doubtful origin but are possibly due to irregularities in the crystal oscillation or imperfections in the crystal. The authors in their papers give at least five lines which they observed and are unable to explain, although from the other six lines they identify four elements.

MR. HAROLD J. COOK, in a communication to *Science* for November 25, maintains that "good

dependable evidence of human artifacts in the Pleistocene of America" has at last been found. The evidence in question comes from a point near the Colorado River, near the south-eastern end of the Staked Plains and near the little town of Colorado, Texas, on Lone Wolf Creek. The first work leading up to the discovery was done in the summer of 1924, when fossil animal bones were discovered by Mr. Nelson Vaughan. The site was visited by Mr. Cook, who checked the geology of the area in May 1925. In taking up a large block of material containing the articulated ribs and vertebrae of a fossil bison, of which the whole skeleton was discovered in association and splendidly preserved, the first artefact, a point, was found under the cervical vertebrae. A second point was found under the femur, and a third was found "in position with the body of this skeleton." These artefacts are large arrow heads or lance points, and are of unexpectedly fine workmanship, being more refined than modern types found in the area, and of distinct culture and design. It is suggested that the animal had been wounded and died on this spot, as the condition in which the remains were found appears to preclude the possibility of its having been water-borne or otherwise deposited. A number of other fossilised remains have been found, but in the season just past no further evidence of man has been brought to light. These fossils occur in valley gravels solidly cemented by calcareous deposits which rest between the present stream erosion and the old triassic walls of the former valley. Everything points to these deposits being entirely undisturbed. Similar bones and types were found in all places where fossils could be located, and included, besides the extinct bison—*Elephas*, *Equus*, and *Camelus* or *Camelops*, as well as others at present unidentified.

THE Linnean Society of New South Wales has just issued a history of its fifty years of activity since its foundation in 1874, for "The cultivation and study of the science of Natural History in all its branches,"

with illustrations of its various homes, and of its successive presidents. It has published forty-nine volumes of *Proceedings* during its career, and is a standing witness to its benefactor, the late Sir William Macleay (1820-1891), who sustained its early efforts and finally provided it with a permanent building and adequate endowment. It has never exceeded 200 members, so that the constant support of its first president has been of essential help to its maintenance. More than twenty thousand pounds were devised by its benefactor for the general use of the Society, the appointment of a bacteriologist and the Macleay fellows. It suffered a terrible misfortune in 1882, when the building in which it was housed was completely destroyed by fire, but by outside help its library was renewed, though all its possessions and official records for the first eight years of its existence were lost. The volume ends with an account of the eighteen Macleay fellows who have benefited by the ample foundation. Few societies can boast of the constant and generous support which this Society has enjoyed and made so effective.

PART 4 of volume 26 of the *Transactions of the Optical Society* is devoted to a description by Dr. W. H. Steavenson of the instruments and apparatus in the possession of Sir William Herschel at the time of his death in 1822, and now preserved by two of his grand-daughters in the old Observatory House at Slough. The collection includes one of the mirrors of the famous 40-foot telescope; one of the mirrors of the 20-foot instrument, a number of mirrors for smaller instruments, flat mirrors for Newtonian telescopes, a number of eyepieces and a complete 7-foot telescope. The apparatus has all been marked by Dr. Steavenson and the grand-daughters of Sir William, and a list is given of all the items with a short description of each. In the case of the mirrors, after cleaning with ether and lemon juice they have been examined as to their optical properties, and they show to what perfection the figuring of them had been brought by Herschel 130 years ago. The whole of the eyepieces are single lenses, the most powerful a double convex of 0.02 inch diameter and 0.01 inch thick. They substantiate Herschel's claim that he obtained powers between 1000 and 6000 on his 7-foot telescopes. Twelve photographs of instruments and observatory complete an interesting and valuable document.

WITH the commencement of our issues for the New Year we shall conduct and publish a column, to be continued weekly, under the title "Contemporary Birthdays." In this the dates of birth of various men of science resident in Great Britain, our Dominions, and in foreign countries will be recorded, and the essential details of the careers of some of them will be set forth, in so far as is possible under the limitations of space which NATURE must observe. The first of the series will appear on January 2.

A CURIOUS problem of the Arctic is noted in the *Geographical Journal* for December. In August 1924 Dr. Livingstone, of the Canadian Government ship *Arctic*, found on Pim Island in Smith Sound, about half a mile inland from the north-west end, part of a

small leather case bearing the Royal Crown and the cypher V.R.I. in gold. The Director of the National Resources Intelligence Service of Canada suggests that this is part of a spectacle case dropped by an officer of the Nares expedition of 1875. The vessels of this expedition appear to have been the only British naval vessels to land parties on Pim Island during the reign of Queen Victoria. A drawback to this explanation is that Queen Victoria did not acquire the title of Imperatrix until 1876, the year of the expedition's return. Furthermore, it seems doubtful if any member of the Nares expedition had an opportunity of going so far from Payer Harbour, some few miles along the coast of Pim Island. The editor of the *Geographical Journal* would welcome information that could throw light on this problem, especially on two matters: evidence of the use of the cypher V.R.I. before 1876, and knowledge of any visit to the north-western extremity of Pim Island before 1924. An illustration shows the leather case. It has not been possible to trace any such gift to any member of the Nares expedition.

THE annual report of the Director of Research to the Council of the British Photographic Research Association shows that members of the research staff are continuing their investigations into the principles that underlie the practice of photography, and that during this year nine papers have been published in various scientific journals. In addition, various summaries of literature and more popular articles have been written, and various confidential investigations carried out for the members of the Association. The staff took a very active interest in the sixth International Congress of Photography held in Paris, and submitted to the Congress the only concrete proposals on the standardisation of plate-testing methods. It is to be hoped that the discussion of this subject at Paris will lead to more uniformity in the expressions of sensitivity and the other properties of photographic plates. The selenium density meter designed by the staff, and referred to in last year's report, has extended the possibility of work on experimental emulsions, and has been appreciated by many other laboratories.

REPORTS of committees appointed to award the Godard and Brocas prizes in the gift of the Société d'Anthropologie of Paris are published in the recent issue of the Society's bulletin (t. 5, sér. 7, fasc. 4-5-6). The Godard prize for 1924 is awarded to Dr. Maurice Neveux for a thesis entitled "Religion des noirs: Fétiches de la Côte d'Ivoire," which embodies observations made in 1909-1910 and 1914-1915, when the author was in charge of the medical services of that area. Two awards of the Brocas prize are made. The prize for 1922 is awarded to Dr. Fritz Sarasin, of Basle, for his work on the anthropology of the New Caledonians, and to Dr. E. Pittard, of the University of Geneva, for his book on the peoples of the Balkans. The prize for 1924 was divided between Dr. Antoine Delattre for a thesis on the comparative anatomy of the axis in mammals, M. Chame, of Bordeaux, for his work on the digastric muscle, and M. Cipriano Lidio, of Florence, on the human patella.

THE brief account by Prof. R. R. Gates of his trip up the Amazon during the summer vacation of 1925, which is published in the *Quarterly Summary of the Royal Botanic Society*, Regent's Park, for October, is a timely reminder that improvements in communication are throwing open this interesting botanical region under much more favourable conditions than previously. The Botanic Garden of Rio de Janeiro has recently circulated particulars of a new biological station, attached to the forest reserve of Itatiaya, which is available for visit by biologists. It is situated in a region where tropical and alpine floras co-exist within a small area, with a range above sea-level from 800 to 3000 metres. A small library is attached to the laboratory at the station, for which the Director of the Botanic Garden solicits further publications from naturalists. The address of the new station is, Estação Biologica de Monte Serrat, Barão Homem de Mello, Estado do Rio, Brazil.

THE *Marine Observer* for December, issued by the Meteorological Office, Air Ministry, completes the second volume, the publication having been issued in monthly parts for two years (London: H. M. Stationery Office; 2s. net each part). The Marine Superintendent of the Meteorological Office is quite sanguine that it fills the place intended, and while it has already stimulated considerable interest from the Mercantile Marine, he appeals to those afloat to contribute articles, sketches, and photographs to add to the value, attractiveness, and utility of the journal. The publication takes the place of the *Monthly Pilot Charts* previously issued, and by preserving the copies intact, much information of value to the navigator is at hand, and, with the index to the separate volumes, there is easy access to the information. No. 24, for December, contains an article by Captain L. A. Brooke Smith, the Marine Superintendent, on "Developments in Wireless and Weather: An Aid to Navigation," and it is clearly shown how valuable the weather information will be to airships over the sea. Much value is attached to the weather registers kept for the Office by the captains and officers in the mercantile marine.

THE *Sitzungsberichte der Physikalischen-medizinischen Societat* at Erlangen is always worth reading. A recent issue (Band 54 und 55, 1922, 1923) contains a number of interesting papers by various authorities, among whom we are pleased to note Prof. Eilhard Wiedemann. Prof. Wiedemann, whose output of articles on the history of science is rivalled only by that of Prof. von Lippmann, here contributes a short study on the history of music among the Arabs. He gives translations of the appropriate sections of the encyclopædic *Mafātīḥ ul-'Ulūm* (Keys of the Sciences) and of Al-Akfānī's *Irshād al-Qāṣid* (The Right Guidance of the Seeker), and illustrates them with very interesting notes and explanations. Other articles of importance are (i.) On a method of estimating the melting-point of gelatin solutions, by Rudolf Reiger and Fritz Gernert, and (ii.) On the construction of the world according to Ibn al-Haitham, by Karl Kohl. A lighter note is struck by Alexander

Gutbier in a popular lecture on "Die chemischen Elemente und der Weltenraum." On the medical side, Reinhold Wissmann gives a long account of his work upon war injuries to the eyeball. This occupies some 150 pages and deals with the subject in a masterly and exhaustive fashion.

WE sincerely share the regret, expressed by Dr. F. H. Gravely in the Report of the Madras Government Museum for 1924-25, "that limitations of staff make it impossible to continue, without neglecting other work of still greater urgency, the ethnological investigations so admirably begun years ago by Mr. Thurston." It is urgent enough that ancient customs rapidly disappearing under modern influences should be recorded without delay. On the other hand, one is glad to note that the University of Madras, by arrangement with the Fisheries Department, is establishing a Marine Biological Station on Krusadai Island in the Gulf of Manaar. Dr. Gravely is therefore preparing an introduction to the littoral fauna of the island.

THE Academy of Natural Sciences of Philadelphia, having managed for more than a century to perform admirable service under an act of incorporation and by-laws dating from 1817, but altered from time to time, at last found it necessary in 1924 to amend the charter and totally to revise the by-laws. The results are set forth in the Year-Book recently issued. Administration by council and curators has been abolished, a board of trustees created to manage the administrative and financial affairs of the academy, and a new council established to act in matters relating to the pursuits of the scientific staff. A new position of director of the museum has been created, and to it Mr. Witmer Stone has been appointed. The various sections of the Academy—geological, ornithological, etc.—have ceased to exist, but their place is taken by the Philadelphia Mineralogical Club, the Delaware Valley Ornithological Club, the American Entomological Society, and the newly formed Leidy Microscopical Club. Thus an easier opening is made for younger students.

ON Tuesday, December 15, the Priestley Club celebrated its jubilee by a dinner in the University of Leeds, to which a number of distinguished guests, representing various phases of activity, in pure and applied sciences, were invited. Sir J. C. Irvine, in proposing the toast of the Priestley Club, contrasted the conditions of experimental work in the days of Joseph Priestley with those which have been made possible by the development of institutions of the type of the newer universities in Great Britain. The advantages afforded by a general scientific society such as the Priestley Club in bringing together for the purpose of discussing scientific topics the various research workers in specialised provinces, were emphasised by Prof. A. Smithells, who pointed out the debt the present members of the Club owe to its founders, amongst whom were the late Sir T. E. Thorpe, Sir Arthur W. Rucker and Prof. L. C. Miall. Other guests included the Vice-Chancellor of the University of Leeds and the Rev. W. L. Schroeder, who

in succession to Priestley is the pastor of the Unitarian Chapel at Mill Hill, Leeds.

MESSRS. Casella and Co., of Parliament Street, London, have recently issued a price list of barometers. The list is well illustrated and a good description is given with each instrument, together with the price and any extra charge for the National Physical Laboratory certificate. Barometers of all descriptions are catalogued, standard instruments of the highest scientific principle as well as more ordinary mercurial barometers for observing stations and for use on board ship, for fishermen or lifeboat stations, and also a pit or miner's barometer. Aneroid barometers of various designs are shown, both large and small, for ordinary use, for mining and surveying, or for special use in aeroplanes. Barographs are listed, and these instruments, which are of great interest to the ordinary public, are of a reasonable price, the guarantee of the firm being of the highest order.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A deputy curator of the Public Libraries, Museum, and Art Gallery of the County Borough of Sunderland—Chairman of the Libraries, Museum, and Art Gallery,

Committee, Town Hall, Sunderland (January 4). A junior assistant (a botanist with good knowledge of chemistry, preferably biochemistry) at the laboratories of the British Cotton Industry Research Association—The Director, Shirley Institute, Didsbury, Manchester (January 13). An assistant at the Mount Stromlo Observatory, Australia—The High Commissioner for the Commonwealth of Australia, Australia House, Strand, W.C.2 (January 15—*extension of date*). The De Beers professorship of mechanical engineering in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner of South Africa, Trafalgar Square, W.C.2 (February 1). A professor of social anthropology (who will be also the director of the school) and a senior lecturer in social anthropology at the School of African Life and Languages in the University of Cape Town—The Secretary, Office of the High Commissioner of South Africa, Trafalgar Square, W.C.2 (February 15). A pharmacist under the Government of Iraq—Crown Agents for the Colonies, 4 Millbank, S.W.1, quoting M/14126.

ERRATUM.—In NATURE of December 12, p. 861, five lines from end of first column, for 15⁴ ergs read 10⁻⁴ ergs.

Our Astronomical Column.

COMETS.—The *Times* of December 16 contains the announcement of the discovery of a new comet in the constellation Reticulum by Mr J. Ensor of the Pretoria General Hospital. It is stated that the comet is not visible to the naked eye, but that it has been observed at the Union Observatory, Johannesburg, and that its tail is 15' long.

The position of the comet on December 14 was R.A. 3^h 38^m, daily motion minus 12^m. S. Decl. 61°, daily motion 24' S.

NAKED EYE SUNSPOTS.—The solar activity recently commented upon in these columns has continued. During the first half of December, two naked eye spot disturbances have been observed. The first of these was seen without a telescope only by persons of keen sight, but the second has been a distinct marking on the sun's disc when screened by fog or artificially with a dark glass. The former group was on the central meridian on December 10, when it was composed of two large composite spots. Although a new and apparently independent centre of activity, this group was not far distant from that of the naked eye group of November 8–20, which has not outlived the rotation.

The second group grew from some spots seen close to the sun's west limb on November 24 and 25, which, when brought again into view on the eastern limb on December 9, had become a long stream stretching 15° in longitude. The axis of the stream was inclined about 17° to the solar equator, the latitude of the leading spot being 21° N. and that of the follower 25° N. At the present phase of the sunspot cycle, spots in this latitude are usual, but groups so large as this present one are more commonly found between latitudes 10° and 15°. These are, of course, the zones most active near the maximum phase of the cycle. A very large group of spots appeared, however, in latitude 32° S. in February 1894, and one exactly on

the sun's equator in May 1921 (see NATURE, vol. 107, p. 399).

Particulars of the recent spots are given in the table below. No considerable magnetic disturbances have been recorded as yet this month at Greenwich.

Date on Disc, 1925.	Central Meridian Passage (G M T).	Latitude.	Maximum Area.
Dec. 4–16	Dec. 10 3	20° S.	1/900
Dec. 9–(22)	Dec 16 0	23° N.	1/500

(Areas are corrected for foreshortening and express the proportion of the sun's hemisphere.)

TOTAL SOLAR ECLIPSE OF JUNE 29, 1927.—It is not too early to commence plans for the eclipse of June 29, 1927, total in Wales, England, and Norway. A large scale map of the track in Great Britain (10 miles to the inch) has been constructed by Mr. B. F. Bawtree (late of the Nautical Almanac Office), and is published in the B.A.A. Handbook for 1926. The central line runs from Crickieth (Carnarvonshire) to Hartlepool, passing through Colwyn Bay, Southport, Settle, and Richmond (Yorkshire). The north limit of totality runs just north of Beaumaris, Bangor, Lancaster, Durham, and just south of Sunderland. The south limit runs a little south of Denbigh, Liverpool, Accrington, Saltburn-on-Sea, and through Burnley.

It must be counted a fortunate circumstance that three of the observatories in the Nautical Almanac list (those of Bidston (Birkenhead), Stonyhurst College, and Durham) lie within the totality track. Stonyhurst specialises both in solar study and spectroscopy, and preparations for the eclipse are already in progress. The altitude of the sun is 13° on the east coast, and the duration of totality increases from 21.6 sec. on the west coast to 24.5 sec. at Hartlepool.

The conditions in Norway are far more favourable both as regards height of sun and length of totality, and those who propose to undertake important researches should certainly go there.

Research Items.

POTTERY FROM ANCON, PERU.—Dr. W. D. Strong has published a further instalment of his valuable studies of the collections of pottery from Peru which were made by Dr. Max Uhle, and are now in the Museum of the University of California. In No. 4 of Vol. 21 of the *Publications in American Archaeology and Ethnology* of the University, he deals with the collections from Ancon, which do not, it is true, exhibit the same variety as the collections from some of the other sites previously described, but are nevertheless of considerable interest as exhibiting what is, in the main, a continuous local development, although outside influence is to be discerned. The earliest pottery found—early Ancon—came from shell mounds and is characteristically a one-colour ware, often unslipped, and with incised rectilinear and curvilinear designs. Dr. Uhle believed it similar to proto-Nazca, but probably it is rather an early widespread Peruvian type from which proto-Nazca developed. In the following period, middle Ancon I, the earliest from the necropolis, two types are found, one resembling early Ancon, the other consisting of polychrome foreign styles showing the influence of proto-Nazca, proto-Chimu, and Tiahuanacu. Middle Ancon II again shows two types, one local, the other a degraded Tiahuanacu of wide distribution. In late Ancon I a "black, red, and white" ware, and late Ancon II, a black and white pottery, foreign influence apparently had little effect. Only in the upper layers is Inca pottery found. Dr. Uhle places the earliest period at approximately 100 B.C. It would seem that Ancon had already been abandoned at the time of the Spanish conquest.

GROWTH IN STATURE OF INFANTS—A recent issue of the *Bulletin of the Société d'Anthropologie de Paris* (T. 5, Sér. 7, fasc. 4-5-6) contains two communications dealing with the modality of growth in stature in infants and the causes of its abnormalities by M. Variot and his assistant, M. Alfred Ruesco, of the Hospital of Notre Dame Perpétuel du Secours. M. Ruesco's results are based upon observations upon 602 infants. He finds that in the first twelve months there is usually a regular upward curve up to six months, but that after that age, in 82 per cent. of the cases, there are breaks in the regularity of the curve which are represented on the graph by horizontal lines—*paliers*—of which the first is the most serious. The duration of these breaks may vary from one week to six or eight weeks. A further analysis of the figures gives the following results:—Interruptions in regularity of curve of growth—infants above normal in weight, 29 per cent.; breast-fed infants, 75 per cent.; breast and artificial feeding combined, 76 per cent.; artificial feeding from birth, 84 per cent.; premature, 89 per cent.; infants below normal in weight, 100 per cent. These percentages bear no relation to absolute height, which may be quite normal, but represent only irregularities in rate of increase. It would appear, therefore, from an inspection of these figures, that there is a close connexion between nutrition and regularity in increase in stature. While food is regular, abundant, and well adapted to the needs of the organism, and nutrition is at the same time uninterrupted by morbidity, as, for example, by the anorexia of dentition, growth in stature is regular and continuous. M. Variot carries the matter further and shows, first, that the nutrition of the osseous system, which governs increase in stature, sometimes proceeds apart from nutrition of the organism generally, which regulates weight; and secondly, that on plotting various crises of the first

year on the graphs, it appears that the *paliers* coincide with eruptions of the teeth.

AERIAL SURVEY OF A DELTA.—The difficulty of adequately surveying the channels and featureless swamps of the Mississippi delta and the need for the revision of the charts of that region suggested the possibilities of aerial survey. Previous experiments on the coast of New Jersey proved the value of these methods. A brief illustrated account of the survey, with notes of the cost, is contained in Special Publication No. 105 of the United States Coast and Geodetic Survey, by Mr. G. C. Mattison. The field work was done in 1921-22 with a seaplane, since the marshy condition prohibited the use of aeroplanes. The seaplane could not attain a higher altitude than 8000 ft., which was found to be a disadvantage. Since the use of aerial photographs was largely experimental, control by triangulation was arranged. The delta was divided into sections with natural features as boundaries, and over each compass flights were made. Flights were also made along the principal channels. The photographs had about 50 per cent. overlaps, and when the work was complete very few gaps between the strips were revealed. Results were fairly satisfactory, but left room for some improvements. At the same time, it is doubtful if ground of this nature could have been so well surveyed, and certainly not so quickly and cheaply, by any other method.

AMMONITES OF PORTUGUESE EAST AFRICA—A collection of Upper Albian Ammonoidea, belonging to the Transvaal Museum form the subject of a paper by Dr L. F. Spath (*Ann. Transvaal Mus.*, 11, Pt. 3). The specimens, which are all from Catuane in Portuguese East Africa, include 33 ammonites and 69 heteromorphs. The fauna is of great interest, for it includes not only important and new forms of *Inflaticeratidae* but also the majority of specimens belong to groups of "Criceras" hitherto known mainly from Australia. The author briefly revises his former opinions based on a study of the Aptian ammonites from Zululand, Madagascar and Angola, recognising now that they came from beds of different and not the same dates. In strictly contemporaneous beds similar assemblages, if not identical species, are found. Ammonites are not only remarkably independent of facies, but are also of surprisingly world-wide distribution. In an appendix three ammonites from the Cenomanian of Maputoland are described.

ICE IN THE ATLANTIC.—The *Meteorological Magazine* for November contains an article by Lieut.-Comdr. Edward H. Smith, U.S. Coast Guard, on ice in the North Atlantic. It was off the tail of the Grand Banks that the giant passenger ship *Titanic* met with the appalling disaster on the night of April 14, 1912, through colliding with a low-lying iceberg. The Ice Patrol Service was established in consequence. The management of the service was accepted by the U.S., several nations sharing the expenses of the project, Great Britain contributing approximately 30 per cent. of the outlay. The Patrol has been operating for the past thirteen years and the U.S. Hydrographic Office co-operates with the Coast Guard in giving publicity to the ice information. The writer claims that there has not been a single life lost or a serious marine accident on the United States-Europe routes since the inception of the Ice Patrol. There are two ships detailed for ice patrol duty. The Patrol finds two general forms of ice, sea ice and land ice. The sea or field ice lasts from

February until May. Land ice consists of parts broken off from the ice sheets which cover certain land areas in the far north, and this constitutes a far greater menace to navigation than does sea ice. The iceberg season covers the period March 15–July 15. Records kept by the Patrol, 1913–1925, indicate a tendency towards uniformity in the drift of icebergs. The amount of ice drifting out of the north into the open Atlantic is subject to great annual variations. Based on past experience in association with correlation of other data, arrangements are now being made to begin a service of North Atlantic ice forecasts beginning with the season of 1926.

ROTATION OF BODIES DURING EARTHQUAKES.—During the St. Lawrence earthquake of February 28, 1925, many bodies were rotated on their bases, and these were examined by Mr. E. A. Hodgson (*Journ. R. Astr. Soc. of Canada*, vol. 19, 1925, pp. 169–178) in the hope that they might throw light on the position of the epicentre. This area is known to lie in an unsettled region between the St. Lawrence and Saguenay rivers and between their junction and Quebec. Though the main object of the inquiry was not attained, it was found that the rotation effects were confined, as a rule, to the region near the epicentre in which the vertical component of the motion was most marked. They depended greatly on the depth of the soil—the deeper the soil the greater the rotation for any given distance from the epicentre—on the slope of the ground and on the presence of tree roots near the monuments. As a rule, the rotations north of the St. Lawrence river were in the clockwise direction, and those on the south side in the counter-clockwise direction; but, while there were practically no exceptions to the rule on the north side, there were a considerable number on the south shore. The author concludes that this old earthquake problem (first considered by Mallet in 1846) is still unsolved.

THE EXCITATION OF HYDROGEN SPECTRA BY COLLISIONS WITH ELECTRONS.—Messrs. P. M. S. Blackett and J. Franck describe experiments in the *Zeitschrift für Physik* of October 20, showing that when very pure hydrogen is bombarded under suitable conditions by cathode rays, a spectrum is emitted which indicates that hydrogen molecules are split up in individual collisions into a normal and an excited atom, the latter afterwards emitting light. Precautions were taken to avoid the accumulation of free atoms in the tube, which included the coppering of the interior walls, cooling the tube with liquid air, and passing a rapid current of low-pressure hydrogen through it, the spectra are due neither to the excitation of neutral atoms by collision with electrons nor to excited molecules. The Doppler effect of the H_{α} line in these experiments was compared with that obtained when many free atoms were present and the spectrum was due to their excitation; it was found to be much greater in the first case, the lines being broadened so that the fine structure observed in the second case became blurred. This is explained as being due to the relative velocity of the two atoms of the dividing molecule. The authors consider it possible that the continuous hydrogen spectrum, reaching from the far ultra-violet to long wavelengths, may be explained as due to the surplus energy available when the molecules are broken up by collision with electrons into two neutral atoms. The continuous spectrum referred to is not that connected with the series limit.

THE CONVECTION OF LIGHT BY MOVING MATTER.—In a recent communication (*Phil. Mag.*, Ser. 6, vol. 49, 1925, p. 579) and in an earlier one (*C.R.*, t. 175, 1922, p. 574) M. Charles L. R. E. Menges has pointed out an

error in the usual deduction on Newtonian principles of the velocity of light in a moving medium, from which the conclusion has been generally and, according to M. Menges, wrongly drawn, that the older electromagnetic theory is contradicted by the results of the experiments of Fizeau and Zeeman on the velocity of light in moving media. If the refractive index of the moving medium be defined as the ratio that the velocity with which the light reaches the moving medium bears to the velocity of propagation of the light within the medium, then according to M. Menges it follows that the proper formulæ for the differences of phase in the experiments of Fizeau and Zeeman are those of Fresnel and H. A. Lorentz respectively, and that the usual incorrect results are due to the use of an incorrect expression for the refractive index, namely, that of the medium, when it is at rest, instead of that which belongs to the same medium when it is moving and when due allowance is made for the change of frequency of the incident light on account of the Doppler effect. Whilst it must be admitted that M. Menges appears to be right in his main contention that a proper choice of refractive index for the moving medium is essential, yet his own deduction is not entirely free from ambiguity, in so far as equation (11) in his earlier and more fundamental paper leads at once to the expression $\mu' = \mu A(n' - n)$, where n and μ respectively denote the frequency and refractive index of the medium at rest, whilst n' and μ' denote the same quantities when the medium is moving. For A , which is a constant of integration, M. Menges puts $(\mu - 1)/n + d\mu/dn'$, as he says, in accordance with the assumption made by H. A. Lorentz that $d\mu/dn'$ does not vary from n to n' . It is not easy to see any sufficient reason for this identification of A , but if its validity be granted, the formulæ of Fresnel and H. A. Lorentz follow at once. Both of these formulæ have been deduced from the special theory of relativity by M. von Laue (*Ann. der Phys.*, F. 4, B. 62 (1920), p. 448); consequently, if the contention of M. Menges be correct, the experiments of Fizeau and Zeeman can no longer be regarded as deciding between the theory of relativity and the older electromagnetic theory.

NICKEL CATALYSTS.—The results of an X-ray investigation of nickel catalysts of different activity have been published by Clark, Asbury and Wick in the *Journal of the American Chemical Society* for November. The catalysts were prepared by reduction with carbon, ethyl alcohol, ethyl acetate, hydrogen and sodium hypophosphite, and they were examined in a spectrograph in powder form in an atmosphere of nitrogen. With the exception of the product obtained by the last method, which was colloidal, the space lattice and type were the same in all cases. No information was obtained concerning the surface of the catalysts. The results do not contradict the generally accepted theory that, above all, the condition of the surface determines the activity.

TOXIC PRINCIPLE OF INSECT POWDER.—In the *Scientific Papers of the Institute of Physical and Chemical Research*, Tokyo, for August 1925, R. Yamamoto gives the results of investigations on the insecticidal properties of insect powder. The insect powder was obtained from the dried flowers of *Chrysanthemum cinerariifolium*, and by extraction with suitable solvents and vacuum distillation a light brown syrup was obtained which was highly toxic to insects. This liquid, called pyrethron, when saponified yielded a liquid and two solid alcohols in addition to two acids, all of which were inactive towards insects. The formulæ for these substances and for pyrethron have been deduced.

The Instituto Oswaldo Cruz.

By Prof. T. D. A. COCKERELL.

FOR many years past I had been receiving the *Memorias do Instituto Oswaldo Cruz*, published at Rio de Janeiro, and sent with the utmost liberality to students and libraries in many countries. I had wondered at the variety and excellence of the papers, and the beautiful illustrations. I had seen some of the scientific results received as of fundamental importance, and incorporated in text-books. Accepting all this with due gratitude and appreciation, it was natural to feel puzzled to know how it all came about. Brazil is a great country, of enormous but largely undeveloped resources. Talk to any one who has been there, or who lived there, and the conversation is certain to drift toward a criticism of Brazilian politics and politicians. To be sure the same sort of

at Lima was also closed during the few hours when it was possible for me to visit it. The Instituto Oswaldo Cruz is so much a working institution that I imagine it is rarely closed during daylight hours, but it is at Manguinhos, a suburb of Rio, and my wife and I were very grateful for the courtesy of the director in sending a car to take us out. Prof. Carlos Chagas, the director, took us over the building, and explained its history and the nature of the work. Oswaldo Cruz was not a man of wealth, but a practising physician in Brazil. Having studied in Paris, and come in contact with the keenest investigators of his time, he returned to Brazil full of scientific zeal. He was able, through his dominating and persuasive personality, to enlist the co-operation of his countrymen,

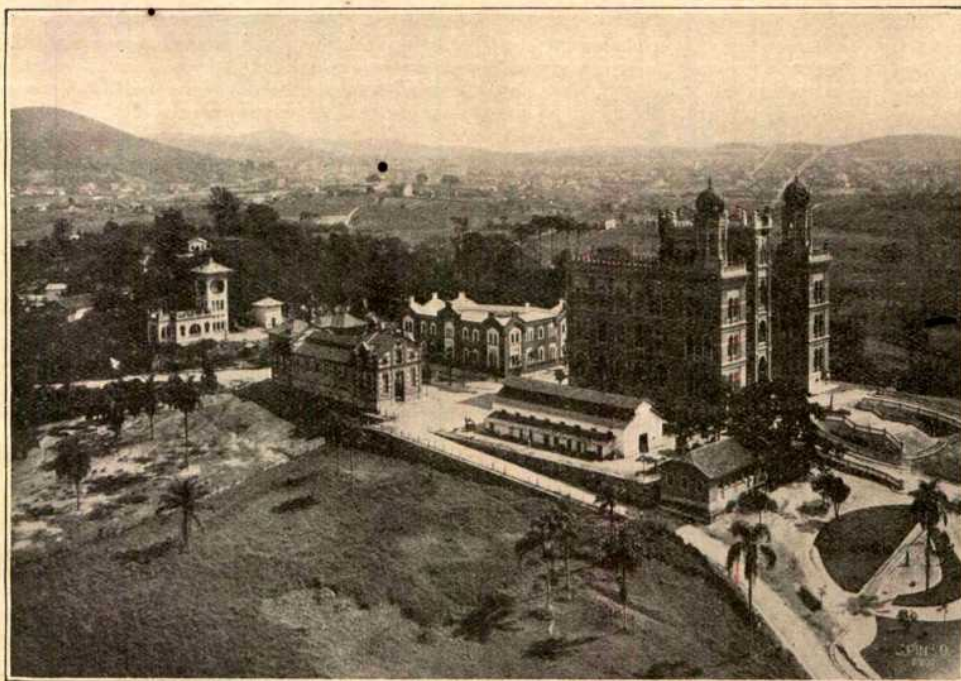


FIG. 1.—The Instituto Oswaldo Cruz.

thing happens in the United States, but we know something of the virtues of the northern continent and can weigh one thing against another. The foreigner approaching Brazil is sure to feel that "every prospect pleases," but more than likely to add that "only man is vile." I myself at one time could only suppose, in a vague manner, that the Instituto Oswaldo Cruz must have been founded and endowed by some multimillionaire, whose munificence had created an organisation essentially alien to the general spirit of the country. This supposition was entirely wrong.

Approaching Rio de Janeiro in the s.s. *Vestris*, and knowing that I should have only a day and a half in the city, it seemed prudent to send a wireless message to the Instituto, to make sure that I should not fail to see it. It is not always easy to get into South American scientific institutions; I found the magnificent museum at Rio closed, with no means of access; I was told that the Botanic Garden was closed; and the La Plata museum in Argentina was closed when I first visited that city. The museum

with remarkable results. He was credited with having banished yellow fever from Brazil, or at least from the populous districts, utilising the results of modern work on the relation between mosquitoes and the fever. Through the work of the Instituto, smallpox has also essentially disappeared, the co-operation of the Government having been secured to make vaccination compulsory. It is evident to any one who gives attention to the subject that the whole problem of Brazilian progress and development is tied up with that of preventing disease. Cruz early perceived that this was the case, and went to work to demonstrate it and obtain public support for his efforts. The response was generous, and the fine building in Moorish style was erected at Manguinhos. Dr. Cruz was the first director, and when he died a favourite disciple, Dr. Chagas, was placed in charge. In a great public building in Rio are large and beautiful mural paintings illustrating the history of the country. Prominent among these is one of Dr. Cruz, represented as ministering to a group of people suffering from various diseases.

The expenses of the Instituto are not derived from any Brazilian Rockefeller or Carnegie; the funds come about half from the Government and the other half from the sale of vaccines and serums which are made there. Thus the whole thing, from first to last, is to be regarded as a flower of Brazilian civilisation, one of the chief instrumentalities for Brazilian progress. As such, it should be known to the world and to the people of Brazil. As I, the foreigner, went over the building, enthusiastic at what I saw, a long-time resident of Rio also went the rounds, and confessed to us that until that day he never imagined what lay so close at hand. The latest number of the *Memorias* (vol. 17, part 2) was just being distributed, containing articles on ciliate Protozoa parasitic in guinea-pigs, a revision of the scorpions of Brazil, an account of worms parasitic in birds, and a statistical study of the incidence of disease due to parasitic worms among the children of Paraná. These papers are in Portuguese, but are accompanied by translations into English or French.

The work for which Dr. Chagas is especially well known is that on the disease called opilacao, caused by a trypanosome which is communicated by a large hemipterous bug, the *Triatoma megista*. The trypanosome was described by Dr. Chagas as *Trypanosoma cruzi* in 1909. The bugs frequent native houses, flying and attacking at night, as was graphically described to me by Dr. C. Spegazzini when I met him at La Plata. Dr. Chagas showed us the parasites in the fibres of the human heart and in the blood of a dog inoculated with injected human blood. Other species of *Triatoma* also carry the parasites. *Triatoma geniculata* gets its trypanosomes from the armadillo, *Dasypus novemcinctus*. The opilacao disease is not coincident with the distribution of *Triatoma*. Dr. E. Escomel of Arequipa, Peru, told me that *Triatoma infestans* was found between Arequipa and Mollendo, but harboured no trypanosomes. He had observed that it was attacked and killed by the spider *Lathrodictes mactans*, common in that region, as also in North America. *Triatoma sanguisuga* of the United States once enjoyed newspaper notoriety as the

"kissing bug," but it appears to carry no trypanosomes. There can be little doubt that it would be capable of transmitting *Trypanosoma cruzi*, were it once infected.

The Instituto has a museum, and a library of 40,000 volumes, in uniform red binding. This is the largest medical library in South America. Behind the main building are smaller ones for physicochemistry and mycology. The department of pathology was started in 1918 under the direction of Dr. Bowman C. Crowell, now of South Carolina. Dr. Crowell had specialised in tropical diseases in the Philippines, and was able to establish the work at Rio on a thoroughly scientific basis. Reports are now made on all autopsies in the Rio hospitals. Thus the progress and incidence of disease is watched with unceasing vigilance. There is of course a good collection of mosquitoes, including those concerned with malaria and yellow fever, the exact distribution of which is mapped. Mosquitoes are such fragile insects that in many collections, especially when much used, they soon become badly broken. At the Instituto this is avoided by placing them in small tubes, pinned on the cork. Thus they can be examined with a lens, without risk of damage. I regretted not to meet Dr. Adolph Lutz, so well known for his studies of blood-sucking Diptera. He was absent giving a course in parasitology in Venezuela, at the request of the Government of that country.

The museum contains a large collection of Batrachia and of poisonous snakes. Dr. Chagas said that Lachesis is the most dangerous form. Around the room are exhibits to illustrate all the important tropical diseases, some of which are little known to people of other regions. Fleas are important in this connexion: the collection of fleas is now being studied by Mr. Cezar Pinto, who has also described species of leeches. There is a small lecture theatre, and courses in bacteriology, proto-zoology, helminthology and entomology are given for graduate students of medicine. Even fresh-water Mollusca (*Planorbis*) have received critical attention, on account of the parasites they harbour.

Recent Researches on the Physiology of the Stomach.

THE large amount of work which has been carried out on the secretory processes and movements of the stomach might suggest that further investigations could add but little to our knowledge; such is, however, far from being the case. Recent advances made in this subject are due in the main to two quite different lines of approach; the improvement in surgical technique has produced more clear-cut results from animal experiments, and the application of these results to man has been facilitated by the discovery of methods of investigating the physiology of the stomach in human beings, whereby essential information, without which the true significance of animal experiments may be obscure, has been obtained.

As an illustration of the former method of advance, recent work by R. K. S. Lim, A. C. Ivy, and J. E. McCarthy may be cited (*Quart. Journ. Exper. Physiol.*, 1925, vol. 15, pp. 13 and 55). The authors, working with dogs, have developed a technique by means of which the entire stomach can be separated from the rest of the alimentary tract; the continuity of the latter is restored by an œsophageo-duodenal anastomosis, while the cut pyloric end of the stomach is made into a permanent fistula, the cardiac end being closed. The animals live well on a diet of ground meat, bread, milk and desiccated pancreas, with unlimited water, but raw meat is passed almost unchanged.

Experiments were also performed on animals provided with different types of stomach pouches and fistulae, following the original technique of Heidenhain and Pavlov and its various modifications.

Consideration may first be given to the arousal of gastric secretion by stimuli acting on the stomach itself; these are of two types, mechanical and chemical. The authors show unequivocally that mechanical stimulation by distension of the organ or a pouch thereof with a balloon causes a secretion of gastric juice, which occurs not only after severance of the vagus nerves, the main secretory and motor nerves of the stomach, but may be seen also in an isolated fundus pouch when the main stomach is distended, or in the stomach when a pyloric pouch is stimulated. There is a latent period of five to fifteen minutes after the beginning of the distension before secretion appears.

These observations are of great interest, not only because they confirm the opinions of some of the older physiologists, whose views have found little favour in modern teaching, but also because they suggest that certain observations on man, in which a mechanical stimulation has been suspected, are probably to be taken as really due to this cause. Many previous observations have shown that a flow of gastric juice can be obtained by the application of certain sub-

stances to the mucosa of the stomach, the authors have confirmed these results, showing that raw meat juice, β -alanine, and histamine stimulate, whereas undigested foods are without effect. The actual mechanism of stimulation is, however, not yet finally settled. The presence of extrinsic nervous connexions is unnecessary, but since a denervated pouch responds to the stimulation of the main stomach, one must assume that the effective stimulus is a chemical agent, carried by the circulating blood.

The authors have been unable to obtain unequivocal evidence of a hormone, such as postulated by Edkins, in the blood, and therefore incline to a view which advocates a common mechanism, as the basis of both mechanical and chemical stimulation. The stimuli produce an increased blood flow through the gastric glands resulting in an increased flow of gastric juice; in the case of mechanical distension, the motility of the stomach is involved in this effect. It is, however, possible that increased blood flow consequent on increased movements due to distension may be concerned only in the effects of mechanical stimulation, whilst the hormone mechanism may explain the results of chemical stimulation, more especially as Ivy reports, in a recent review of the subject, that a gastric pouch transplanted to a mammary gland secretes when gastrin (an extract of gastric mucous membrane) and histamine are applied to the surface of the main stomach, in which case an increased blood flow seems scarcely adequate as an explanation (*v. Journ. Amer. Med. Assoc.*, 1925, vol. 85, p. 877). It is to be noted, moreover, that in the case of the secretion of saliva, an increased blood flow through the salivary glands does not produce an increased secretion.

The gastric juice produced by local stimulation of the stomach is only part of that secreted in response to a meal. Before the food enters the stomach secretion occurs, produced reflexly by impulses set up by the sight and smell of the meal, together with those arising from its presence in the mouth itself. The arcs concerned in the latter reflex are situate in the brainstem, since the "psychic" secretion, as it is called, occurs in a decerebrate dog when given food. But Lim, Ivy, and McCarthy have added yet a further period to the secretion of gastric juice by showing that it is aroused by the application of digestion products such as peptone, amino-acids, and amines to the mucosa of the small intestine. If a meal were given to their dog with a pouch of the entire stomach, a

secretion of gastric juice occurred about one to three hours later, depending in part on the time for digestion in the small intestine, in part on the time of appearance of the bile, which also acts as a stimulant. Hence gastric secretion can be divided into three phases, a cephalic (or "psychic"), a gastric, and an intestinal. It is only on an accurate knowledge of these processes that a rational therapy of gastro-intestinal tract disease can be based.

A certain amount of doubt has arisen as to the actual nature of the movements in the stomach, chiefly owing to the fact that different types have been described in man and animals; sometimes even different observers have found different appearances in the same species. E. D. McCrea, B. A. McSwiney, J. W. Morison, and J. S. B. Stopford (*Quart. Journ. Exper. Physiol.*, 1924, vol. 14, p. 397) have investigated the movements of the stomach in the rabbit, cat, dog, and man, both by means of the X-ray and also, in the animals, by direct inspection of the organ exposed under saline. Their observations clarify and correlate those of previous investigators. The fundus and part of the body of the organ remain almost quiescent during digestion, slowly contracting on the mass of food and forcing it into the more distal parts. In the latter two types of movements occur; in both there is a peristalsis of the remaining part of the body, but in one this is arrested at the pyloric antrum, whilst in the other the wave passes over it and reaches the pylorus; in the former case the peristaltic wave over the body is followed by contraction of the pyloric antrum and canal as a whole, in the same manner as the heart contracts in systole. The first type of movement is predominant in the stomach of the dog, rabbit, and man, the second in that of the cat; but occasionally the opposite type may occur, except that the second has not been observed in the dog's stomach. A transitional form is sometimes seen, namely, ripples running over a tonically-contracted pyloric antrum. The rhythms of the two parts of the stomach may be different. Movements can also be seen in the quiescent part of the fundus in man if the air-cap is displaced and its place taken by the barium sulphate meal. The authors conclude that the variations observed are due to differences in the type and consistence of the food, in the degree of tension in the muscular wall, and in the actual arrangement of the muscular fibres therein in the different species. The research system atises the somewhat confusing observations which have been previously made on this subject.

American Work on Tides.¹

THE United States Coast and Geodetic Survey has done useful service in issuing the special publications referred to below. The manual prepared by Mr Schureman was designed primarily for the tidal computers of the Survey, but the aim was to produce a convenient work of reference on the subject of the harmonic analysis and prediction of tides. It gives a résumé of the work of Kelvin, Darwin, and Harris. Part I. is devoted to the development of the tide-generating force, to the methods of analysis used by the Survey, and to a description of the U.S.A. tide-predicting machine. The method of analysis is worthy of comment. It makes use of several thousand stencils for the special summations required for the isolation of the constituents. The manual indicates, apparently for the first time, some of the more recent improvements in the method, and these are such as

to diminish considerably the labour of calculation. In older methods only those constituents of which the speeds are exactly in the ratios 1 to 2, 3, 4, 6 and 8, were treated together until the final processes of the analysis were reached, but in this method constituents the speeds of which are approximately in these ratios are treated together in the earlier stages of the summations, and "secondary stencils" are then used to isolate the respective constituents.

Parts II. and III. are most useful to computers and research workers in other countries. Part II. contains tables of standard functions used in analysis and prediction, Harris's tables having been extended and others added. The astronomical arguments are now given from 1850 to 1999. Part III. consists of a noteworthy list of harmonic constants for nearly a thousand places scattered throughout the world. Hitherto research workers have had difficulty in obtaining lists of such constants, and no such comprehensive list has ever been published, though no doubt several manuscript lists have existed. The Survey has received constants from many sources,

¹ A Manual of the Harmonic Analysis and Prediction of Tides, by P. Schureman; Tides and Currents in New York Harbour, by H. A. Marmor; Tides and Currents in San Francisco Bay, by L. P. Disney and W. N. Overshiner; A Portable Automatic Tide Gauge, by G. T. Rude. Special Publications Nos 98, 111, 115, 113. (Washington: Government Printing Office.) Prices 100, 30, 20, and 10 cents respectively.

and it must have been difficult at times to make sure that the constants were accurately given. The amplitudes for Gibraltar are ten times too great, but in general the constants appear to be trustworthy.

An immense amount of labour must have been expended in preparing these tables, and all concerned in the production of the manual deserve congratulation upon the efficient manner in which the work has been carried out.

Another activity of the Survey is shown by the two publications dealing with the tides and currents in New York Harbour and in San Francisco Bay. Altogether apart from their importance in navigation, tides and tidal currents enter as important factors into a number of problems connected with harbours and ports. These special publications are not devoted to the discussion of any involved mathematical theory of tides and currents, but are intended to present and discuss the results of observations in such a manner that they will be of interest and practical value to the mariner, the engineer, and the scientific worker. Mr. Marmer's introduction, however, is an admirable statement in simple language of the general characteristics of tides, and this is reprinted in the second publication.

The heights of various planes, such as mean sea level, mean tide level, mean high-water level, storm high-water level, and so on, from year to year are tabulated, explained, and discussed. Engineers must find this information exceedingly useful. Maps give the

directions of current flow at intervals of time related to high-water time or to the time of high-water slack.

The importance of tidal currents is becoming increasingly recognised, and the Survey has taken the lead in preparing a separate annual volume of predictions of tidal currents. Hitherto, the current predictions for San Francisco Entrance refer only to the times of slack water for each day of the year, with suitable indications as to whether the current is about to turn from east to west, or vice versa. Beginning with the year 1926, however, the predictions will be considerably elaborated. For each day will be tabulated the time of slack water before flood, the time and velocity of each maximum flood, and corresponding times and velocities connected with the ebb. It will be noticed that fifty per cent. more information is given for the currents than for the elevations.

To meet the need for a portable tide gauge suitable for the use of hydrographic parties requiring tidal observations during a period of soundings, an instrument has been designed which appears to have reached almost the lowest practical limit of size. When encased, the instrument is almost a cube of 11 inches side, and it is supported on $3\frac{1}{2}$ -inch stock iron pipe which serves as a float-well at the same time. According to Commander Rude the apparatus will function for a week without attention. The gauge appears to be well suited to the purposes for which it is designed.

A. T. DOODSON.

Research in Textiles.

THE Fabrics Co-ordinating Research Committee was appointed in 1921, its members being representatives of the fighting services, the National Physical Laboratory, and the research associations for the textile industries. The duties of the Committee are the maintenance of co-ordination between research work on fabrics carried out by Government departments and others, and the direction of new investigations which appear necessary in the national interest and of civilian as well as of naval or military importance. The report recently issued¹ on the activities of the Committee during the past four years gives a lucid summary of progress in the scientific investigation of several problems of considerable national importance and of very diverse character.

The academic research worker will be interested to learn how frequently, in the solution of such problems, the application of laboratory results is limited by considerations apparently foreign to the subject, a striking illustration being afforded by the search for an antiseptic which will give protection to a fabric from the attacks of micro-organisms and, at the same time, have no deleterious effect upon it. This seemingly simple problem becomes very complex in practice, most antiseptic substances being excluded on account of some objectionable quality or an equally objectionable action on the properties of the fabric or the substances employed in dyeing or finishing this.

The Committee has initiated work on the deterioration of fabrics by the action of light, a problem of great urgency in connexion with aircraft, clothing and tentage, and a summary is given of recent work on the determination of the destructive band of the sun's spectrum (3900 Å.U. to 3100 Å.U.), the protective action of dyes having an absorption band covering this region, and the mechanism of deterioration. Much further work on the latter subject is required, for the causes are still obscure; but an interesting theory of the action of ozone in the

connexion is outlined. This takes account of the oxygen adsorbed by the fibres and the possibility of this being ozonised by the direct action of sunlight, and is based upon a calculation by Lindeman that the ozonisation of the adsorbed air may be effected by light of wave-length 3200 Å.U.

Future progress depends largely upon the provision of more suitable sources of light for experimental purposes than sunlight or the mercury vapour lamp, and a more delicate means of measuring deterioration than the strength test. It is satisfactory to learn that research is being conducted on both these subjects.

An interesting appendix on the deterioration of fabrics by micro-organisms sketches the organisation of a large-scale attempt to collect systematically the organisms capable of causing the decay of fabrics. Specimens of the latter are being exposed, under the supervision of mycologists, at a number of stations in the British Empire, and arrangements are being made for the examination of the specimens after exposure. Again, the possibility of a more suitable test of deterioration than those now available requires further exploration.

A large section of the report is devoted to a comparison of fabric strength tests carried out on machines of different makes and capacities. From a technical point of view this is probably the most important section, for the results are of direct practical significance. They should, naturally, be read with great interest by all concerned with the mechanical testing of fabrics and the scientific investigation of the principles underlying the methods employed.

As a précis of the results of scientific research the report is highly commendable. A misleading statement has been noticed on p. 30, where it is stated, in a discussion of rate of loading, that, when textiles are broken, a larger percentage of the interlaced fibres are "disentangled" and slip past one another without breakage. So far as the writer is aware, there is no evidence supporting this generalisation, which, for example, certainly does not apply to a fine yarn broken on the ballistic tester.

F. SUMMERS.

¹ Department of Scientific and Industrial Research. First Report of the Fabrics Co-ordinating Research Committee. Pp. iv+70. (London H.M. Stationery Office, 1925) 1s. 9d. net.

• University and Educational Intelligence.

BIRMINGHAM.—At a degree congregation held on December 18, the degree of D.Sc. was conferred on Douglas Heber Ingall for five published papers mainly on the relation between mechanical properties of metals and alloys and heat treatment and cold-work.

THE annual distribution of prizes was held at the Sir John Cass Technical Institute on Tuesday evening, December 15, when the prizes and certificates were distributed by Sir Thomas Kirke Rose, past president of the Institution of Mining and Metallurgy. The Chairman of the Governing Body, the Rev. J. F. Marr, in giving a summary of the work of the Institute for the past session, stated that real progress has been made in consolidating, strengthening and correlating the work of the science departments, in which more accommodation is much needed for advanced and research work. Twenty-seven students have been engaged in research work during the session and 11 investigations have been published, bringing the total number of papers issued from the Institute to 165. Following the distribution of awards, Sir Thomas Kirke Rose delivered an address on "Metallurgy and Mining," in the course of which he emphasised the effect the Institute has had in helping the industries of the neighbourhood and not least in its metallurgical work in aiding the Royal Mint. He dealt at some length with the still unsolved problems of minting which have so far baffled metallurgists, in order to bring out the fact that there are still worlds to conquer even in such an old-established industry as minting.

SALARIES of university professors in the United States increased rapidly after the War, so much so as to cause some temporary embarrassment to the administrators of the Carnegie Pension Fund. In the *Forum* for October, however, Dr. Frank Bohn asserts that college and university faculties are being deserted by their first-class members at a rate which calls for a drastic reform of the salary schedules. In a case which he cites as typical, a professor of psychology left the university where he was receiving 5000 dollars a year, and accepted an advertising position in New York in which he was able to earn five times as much. Dr. Bohn suggests that all major gifts to the universities, say those amounting to ten million dollars or more (which totalled during the past ten years no less than 1,435,500,000 dollars) should during the next ten years be devoted to the increase of salaries of university teachers. He holds that the starvation of the teaching profession is destroying the very foundations of higher education, and civilisation is in jeopardy of being submerged in "the noisy flood of ignorance and vulgar materialism." The universities are becoming less and less capable of fulfilling the hope of a generation ago that they would be the prophets, the priests, and the philosophers of democracy. Nor is "starvation" of their professors the only reason. "They suffer primarily from elephantiasis, and the first step might well be a restriction of the number of students by imposing entrance tests which would be at least as severe as the general demands made of the Rhodes scholars. The group of professional schools should include only law, medicine, education, public administration, and the beaux arts. The number of students being thus reduced to, say, 1500, and the professors' salaries being raised to 20,000 dollars as a minimum, the universities' best teachers would no longer seek to escape on the first convenient opportunity, and the intellectual élite of the land would be drawn to them.

Societies and Academies.

LONDON.

Physical Society, November 13.—R. G. Edwards and B. Worswick. On the viscosity of ammonia gas. The viscosity of ammonia gas has been determined at three different temperatures by transpiring the gas through a capillary tube which had previously been calibrated with air. Sutherland's constant is found to be roughly 370, and the mean collisional area of the ammonia molecule 0.633×10^{-16} sq. cm.—T. G. Hodgkinson: Valve maintained tuning forks without condensers. The conductance of the valve grid decides the direction in which the electrode coils must be wound. It is also advantageous, particularly in the case of low frequency forks, to interpose transformers between the valve electrodes and the fork magnets.—C. Chree: The times of sudden commencements (S.C.'s) of magnetic storms: observation and theory. Dr. Bauer's early claim that S.C.'s are propagated from east to west or west to east, with velocities of from 100 to 200 kilometres per second, has been criticised adversely. Since then, Prof. S. Chapman and Fr. Rodés, of the Ebro Observatory, have propounded theories differing from one another and from Dr. Bauer's. Recently Dr. Bauer and Mr. W. J. Peters have concluded that the motion in longitude is much more rapid than according to Dr. Bauer's original estimate, and that it is really a case of propagation from the magnetic equator towards either magnetic pole. The Section of Terrestrial Magnetism and Electricity of the International Union of Geodesy and Geophysics has recently approved a scheme aiming at the construction and use of special instruments to find out whether S.C.'s have a finite rate of propagation. Suggestions are made as to the new apparatus and the stations most suitable for the investigation.

Royal Microscopical Society, November 18—Sydney Dickenson. A simple method of isolating and handling individual spores and bacteria. The spores or bacteria are moved from place to place under continual observation in a local thickening of a water film. This water film is formed between a film of agar and a fine glass rod, which is moved in three dimensions by an apparatus designed for the purpose.

Royal Meteorological Society, November 18—Sir Gilbert Walker and E. W. Bliss: On correlation coefficients: their calculation and use. An account is given of a new method of working out correlation coefficients. Calculations are shown (i.) of the likelihood that with a given coefficient r , the forecast and the actual departures will have the same sign, and (ii.) of the frequency with which, r being given, it will be possible to make a forecast with a 4:1 chance in its favour.—Catharine O. Stevens. Note on the variations in transparency of the atmosphere observed by means of a projected telescopic image of the sun. There is relation between the colours associated with a projected telescopic image of the sun in a darkened room and issues of weather. Meteorological conditions normal to clear weather with rising barometer yield a predominance of red, orange, and blue, to the exclusion of other colours. With steady barometer and cloudless sky, any pronounced departure from this colour-scheme is informative. Thus, if green is included, rain threatens; if purple or violet, electrical conditions are indicated; and in case all colour is whitened, a fall of barometric pressure is heralded.—N. L. Silvester. Notes on the behaviour of certain plants in relation to the weather. The analysis of 1300 observations upon pimpernel, daisy, chickweed, clover, dandelion, marigold, and gentian

to test the local forecast value of plants reputed in weather-lore gives a negative answer. Temperature of the soil surrounding the roots is a control factor in the movements of daisy and chickweed. Above the critical temperature in these two plants, and in the pimpernel, relative humidity becomes the dominant factor—a value of 80 per cent. approx. being the critical maximum in every case. Clover leaves respond to wind velocity. The closing movement commences when the velocity at 42 ft above the surface exceeds 20 m p h. Plants responding to relative humidity can thus be used for prediction of rain only in so far as its incidence is preceded by the pre-requisite humidity increase.

Society of Public Analysts, December 2.—J. S. Owens: Measuring the smoke pollution of city air. The methods of measuring smoke pollution are based on: (a) Measurement of deposit from the air; and (b) measurement of suspended matter before it is deposited. The methods of the Advisory Committee on Air Pollution fall under the headings of: (1) Measurement of deposit by means of standard gauges, (2) measurement of suspended impurities by means of automatic filters, or records; and (3) measurement with the Owens' jet dust counter. The material trapped on dust records from 50 c.c. of air on an average winter's day in London weighs about 1/20,000 mgm, and consists of about 600,000 particles.—Oscar L. Brady and Gladys V. Elsmie. 2:4-Dinitrophenylhydrazine as a reagent for aldehydes and ketones. Aldehydes and ketones can be identified by the crystalline forms, colours and melting points of the dinitrophenylhydrazones which they yield with 2:4-dinitrophenylhydrazine. A solution of the hydrochloride is a suitable reagent for aldehydes and ketones soluble in water; it gives a filterable precipitate with 0.003 gm. of acetone or acetaldehyde.—Gunner Jørgenson: The determination of phosphoric acid as magnesium ammonium phosphate. The most trustworthy method of obtaining magnesium ammonium phosphate of the correct composition is to precipitate it from a nearly boiling solution (accuracy about 1:1000). This is the only sufficiently exact method for determining phosphoric acid in mineral phosphates and fertilisers. Precipitation of ammonium phosphomolybdate in the cold is less accurate (accuracy about 1:100). Precipitation of magnesium ammonium phosphate from a cold solution gives a precipitate much affected in composition by the conditions of precipitation.—C. H. Thomson: On the effect of blowing on the composition of certain fatty oils. The rise or fall in the composition, viscosity, and other constants of cottonseed, whale, sperm and shark oils are simultaneous at each stage of the process, but the rates of change are not the same. The changes produced by varying the conditions of "blowing" are not comparable, except that the viscosity and refractive index rise simultaneously. None of the oils after "blowing" yields ether-insoluble bromides.

CAMBRIDGE.

Philosophical Society, November 23.—R. C. Punnett. On a case of matriclinous inheritance in *Antirrhinum*.—J. B. S. Haldane: The change with age of a linkage between Mendelian factors in fowls.—M. S. Pease. A note on the inheritance of yellow fat in rabbits.—K. Emeléus: Notes on the electrical counter.

DUBLIN.

Royal Dublin Society, November 24 —K. C. Bailey. The radiations from radon promote interaction of

ammonia with either carbon monoxide or carbon dioxide. In both cases ammonium cyanate and urea were formed. No ammonium cyanide was thus obtained from ammonia and carbon monoxide.—Paul A. Murphy and R. McKay: Methods for investigating the virus diseases of the potato, and some results obtained by their use. Most experiments on these diseases require two years to carry out, and necessitate keeping the plants free from insects during the first year. A method is now described whereby tubers may be infected with the mosaic diseases during the winter and the final results secured in June, the plants being grown in the open field. The method is more trustworthy than any previously used. It also separates the mosaics from leaf-roll. Methods more exact than those hitherto used are described for determining the rate of spread of the virus in a plant.—E. J. Sheehy: An examination of the errors introduced by the various approximate methods used for estimating the total quantities of milk and butter fat produced during a lactation.

MANCHESTER.

Literary and Philosophical Society, November 24.—Kenneth M. Smith: A study of the feeding methods of certain sucking insects in relation to the spread of "virus diseases" of the potato by such insects. "Mosaic" disease in potato is disseminated by insects, more particularly by those of the sucking type, such as aphides or leaf-hoppers. The whole process of infection of a healthy potato plant with mosaic disease would appear to be somewhat analogous to the infection of man with malaria by the mosquito. The insects have been studied with the sucking organ *in situ* in the tissue of the plant host. By this method it is possible to determine the exact part of the tissue tapped. Other points elucidated include the effect of the salivary secretions of the insect upon the health of the plant, the path followed by the beak through the tissue, *i.e.* an inter- or intra-cellular path, and the method of penetration of the cells, whether by pressure alone or by the solvent effect of the saliva upon the cell walls. Those insects which tap the phloem of the vascular bundles seem to act as carriers. Undue disorganisation of the surrounding tissue by the salivary secretions of the insect may tend to isolate the virus and thus prevent infection. This appears to be the case with certain insects the saliva of which is unusually toxic to the plant.

PARIS.

Academy of Sciences, November 16.—E. Fichot: The submarine relief of the Bay of Biscay. The supposed plateau in the Bay of Biscay does not exist. The outline is unchanged since the survey made in 1828.—Jean Baptiste Senderens: The preparation of the ether oxides of the fatty series. Details of the preparation of ethers from heptyl, cetyl, secondary amyl, and allyl alcohols, using sulphuric acid as catalyst.—Ernest Laura: An extended class of surfaces.—Georges Bouligand: Some points in the theory of harmonic functions.—A. Guillet: The chronostrobometer.—Alex. Véronnet: Equilibrium through the influence of radiation alone is impossible in the sun and in the stars. Internal equilibrium is isothermal and homogeneous.—Paul Helbronner: The geodesic junction of Corsica and continental France.—Mlle. A. Serres: A new magnetic state of the cobalt ion Co.—A. Portevin and P. Chevenard: The influence of cold hardening and of tempering on the elastic properties of various metals and alloys.—A. Petit: Contribution to the study of the aluminium silicon

alloys.—Díaz de Barros: The nuclear numbers. The nuclear number is defined as a whole number equal to half the difference between the atomic weight of an element and its atomic number. Some properties of the numbers thus defined are given.—Raymond Delaby: The isomerisation of the vinyl-alkyl-carbinols $\text{CH}_2:\text{CH}.\text{CH}(\text{OH}).\text{R}$ into β -alkyl-allyl alcohols $\text{CH}_2(\text{OH}).\text{CH}:\text{CH}.\text{R}$. The chain of reactions is as follows: addition of bromine, action of sodium formate, decomposition by heat of the diformin and saponification of the formic ester of the primary alcohol required. The operations are simple and yields fair (20 per cent.).—René Bourret: The Annamitic cham and the Bas-Laos plateaux to the west of Hué.—Eugène Raguin: The discovery of a fauna of Foraminifera, very probably Cretaceous, in the highly metamorphosed limestones of the Vallon du Pâquier near Grand-Motte (Savoy).—R. Cerighelli: The influence of the conditions of the medium on the germination of seeds in the absence of calcium. Whether the culture medium is sterile or not, the cotyledons immersed or not, or whether the water is present as liquid or vapour, it is proved that seeds cannot germinate properly in the absence of calcium.—V. Lubimenko: Chromatic adaptation in the marine algæ. Marine algæ are very poor in chlorophyll, the amounts found varying from 37 per cent. (green algæ) to 18 per cent. (red algæ) of the amount usual in higher plants. The red algæ adapt themselves to the light in two different ways: each species increases or diminishes the total quantity of pigment according to the depth. The proportion of phycoerythrine varies with the different species increasing with the depth below sea-level.—Eberhardt and J. Chevalier: A new treatment of the diseases of the potato. The plants are sprayed with an emulsion of a thiohydrocarbon derived from resin by a simple process. The results of experimental cultures with eight kinds of potato are given. The treatment destroys parasites, arrests the development of fungi, and gives an increased weight of crop.—E. Séguy: The characters common to the Ostridæ and the Calliphorinæ.—Maurice Piettre: The preparation of the albumen of muscle or myoalbumen by the acetone method, its principal properties. Full details are given of the method adopted for the separation and purification of myoalbumen. Its properties are similar to those of serum albumen, lactalbumen, and ovalbumen, but is differentiated by coagulating at 45° – 47° C., not as a fine sandy precipitate but in small flocks, and by its specific rotatory power, about half that of serum albumen.—Max Aron: The evolution of the genital glands of young tritons transplanted into adults of the same species. The idea of internal conditions limiting the development of the sexual cells.—Constantin Gorini: *Gastrococcus*.

SYDNEY.

Linnean Society of New South Wales, September 30.—R. J. Tillyard: A new fossil insect wing from Triassic beds near Deewhy, N.S.W. Description of a wing which, from a study of its venation, is placed in a new family in the order Protohemiptera.—J. R. Malloch: Notes on Australian Diptera. No. vii.—I. M. Mackerras and M. J. Mackerras: The Hæmatozoa of Australian marine Teleostei. The blood of 200 marine Teleostei taken in the vicinity of Sydney, N.S.W., was examined. Two new species of *Trypanosoma* and three of *Hæmoglobarina* are described, thus bringing the Australian hæmatozoal fauna into line with that of other parts of the world. In addition, a new species of *Trypanoplasma* is described, this being apparently the first record of the occurrence of a member of this

genus in the blood of a marine fish.—G. H. Cunningham: *Gasteromycetes* of Australasia. (iii.) The genera *Bovista* and *Bovistella*. Two species are allowed to remain in *Bovista*, six of those recorded in Cooke's Handbook being excluded from the genus. In *Bovistella* three species are retained and seven species are excluded on the ground that they possess the typical *Lycoperdon capitatum*.—R. Greig-Smith: The influence of certain colloids upon fermentation. Pt. II. Yeasts and bacteria have their fermentative activities accelerated by the presence of certain minerals and other colloids such as talc, kieseguh, silica, fuller's earth, charcoal and agar. The isolated enzymes are not influenced by the same colloids.

Royal Society of New South Wales, October 7.—R. H. Cambage: *Acacia* seedlings (Pt. xi). The first half-dozen or so of the youngest leaves first assume a recumbent position, and may actually lie down on the ground before closing their leaflets at night. Tests were made to ascertain the strength exerted by these tender leaves when regaining their upright position in the morning, and it was found that with a weight of 0.227 gm. placed at 6 cm. from the base of a leaf 8 cm. long, the terminal point of the leaf in one case was carried upwards 6.5 cm.—H. R. Seddon, W. L. Hindmarsh, and H. R. Carne: Further observations on *Stachys arvensis*, "stagger weed," as a cause of staggers or shivers in sheep. As frequently happens with poisonous plants, it is not equally noxious at all stages, and its harmfulness depends to some extent upon the type of sheep which are fed upon it. Thus it has happened that certain feeding experiments have been entirely negative, whilst in others all animals have developed staggers. Green, succulent plants produce staggers, whereas yellowish, harsh plants are comparatively or entirely harmless. The staggers-producing principle seems to be most abundant in, if not confined to, the seed, and is contained in the ether-soluble fraction of the seed. When removed to other feed, sheep rapidly lose the staggers condition, certainly within a week. Young animals are much more susceptible than adult sheep.—F. R. Morrison: The fixed oil of the seeds of the Kurrajong (*Brachychiton populneum*, Syn. *Sterculia diversifolia*, G. Don). The oils obtained by extraction with ethyl ether and light petroleum ether respectively, were of a golden-yellow colour, and consisted of the triglycerides of palmitic, oleic, and linolic acids, together with smaller quantities of free palmitic, oleic, and linolic acids. The oil is thus of the semi-drying class.—M. B. Welch: Notes on the principal indigenous timbers of the natural order Saxifragæ. There are about twenty genera in Australia, of which twelve are endemic and many are monotypic. Eight genera produce trees which reach a large size, and notably *Ceratopetalum*, *Weinmannia*, *Geissois* and *Ackama* are of commercial importance. The woods are diffuse-porous, the vessels bearing either scalariform or simple end perforations. The wood fibres show transition stages to fibre tracheids and even tracheids. The rays are normally heterogeneous and multiseriate.—R. K. Newman, V. M. Trikojus, and G. Harker: The use of phosphorus pentachloride in the preparation of glycerides. The preparation of a simple fatty substance, tributyrin—a compound of glycerol and butyric acid—is described. Two methods employed gave high yields. In one of these phosphorus pentachloride acts upon a mixture of glycerol and sodium butylate; in the other the tributyrin is prepared direct from glycerol and butyric acid, while special means are provided for the continuous removal of the water formed during the reaction. The pure tri-

butysin prepared by either process has a much higher boiling point than that usually accepted, namely, 315.5° instead of 287°C . No matter what method was used, the same triglyceride was always formed, and there was no evidence of isomerism.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 11, No. 11, November).—Edward W. Berry. The age and affinities of the tertiary flora of western Canada. The flora seems to be mainly late Eocene and consists of hardwood assemblages of broad leaf types and coniferous trees resembling existing species in the Chinese uplands. The major element, of newer types, probably entered North America from Asia by land connexions in the Bering Sea region during the Upper Cretaceous or earlier Eocene.—S. Loria. The metastable $2p_2$ -state of mercury atoms. A mixture of mercury vapour, thallium vapour, and nitrogen illuminated by light of wave-length $2537\text{ \AA}$.U. gives activated mercury atoms in the $2p_2$ -state. On collision with nitrogen molecules, the main part of the activation energy may be retained in the $2p_2$ -state of the mercury atom. The time for which the atom retains this energy depends on the surrounding gas, and can be measured, in this case, by the increase in intensity of the fluorescence spectrum of thallium.—H. D. Smyth. Some experiments on collisions of the second kind. Iodine vapour at a high temperature contains electrons with energies greater than that corresponding to the electron affinity of iodine (3.5 volts), due apparently to "collisions" in which an electron approaches a system of neutral iodine atom and electron; i.e. collisions of the second kind. Some evidence was also obtained with ozone that the critical increment of energy for decomposition is dissipated in a similar way.—Vladimir Karapetov. General criterion for the circular locus of the current vector in A.C. circuits and machinery.—Edward V. Huntington. Postulates for reversible order on a closed line (separation of point-pairs).—Raymond Dodge. The hypothesis of inhibition by drainage. The hypothesis assumes that there is a definite amount of available neural energy in the nervous system which can be concentrated into specific neural paths and consequently drained from others. Using the knee-jerk and wink reflex in the human subject, it was found that the reflex action is unmodified by voluntary reaction to the stimulus. The hypothesis is therefore discarded pending new evidence.—George E. Hale. A test of the electromagnetic theory of the hydrogen vortices surrounding sunspots. There is no relationship between polarity and direction of whirl in 51 sunspots taken at random from three 11½-year cycles. It would appear that hydrogen vortices are hydrodynamical phenomena rather than electromagnetic (Stormer). Direction of whirl is determined, not by the sunspot vortices beneath them, but by the east and west deflexion, due to solar rotation, of currents flowing northward and southward towards centres of attraction above sunspots.—John W. Gowen. Recent evolution in milk secretion of Guernsey cattle. From the records of the Guernsey Advanced Registry animals, it appears that there has been considerable increase in average age-corrected milk yields, little change in butter-fat percentage, and continuous decrease in age of cows tested. The results are due to improved knowledge of feeding and care as well as to inheritance.—Calvin B. Bridges. (1) Elimination of chromosomes due to a mutant (*Minute-n*) in *Drosophila melanogaster*. (2) Haploidy in *Drosophila melanogaster*. Two individuals

carrying haploid tissue were found; the tissue in each case was female.—Henry D. Hooker. Plant growth. Carbohydrate accumulation precedes the rest period of shoots and the formation of flower-buds, suggesting that it inhibits or retards leaf formation and thus carbohydrate manufacture. These facts are in accord with the idea that plant growth is a consecutive, reversible monomolecular reaction, and a mathematical formula is developed.

Official Publications Received.

- Annals of the Cape Observatory Vol. 8, Part 7. Occultations of Stars by the Moon, observed at the Royal Observatory, Cape of Good Hope, in the Years 1907 to 1922. Under the Direction of S. S. Hough. Pp. 326. 6s net. Vol. 8, Part 8: Determination of the Elements of the Moon's Orbit, the Parallax Inequality and the Moon's Semidiameter, from Occultations of Stars by the Moon observed at the Royal Observatory, Cape of Good Hope, in the Years 1880 to 1922. By Dr. H. Spencer Jones. Pp. 47H. 4s 6d. net. Vol. 13, Part 1: Proper Motions of Stars contained in the Cape Fundamental Catalogue of 1846 Stars for the Equinox 1900. Computed under the Direction of Dr. H. Spencer Jones. Pp. vi+150. 35s. net. (London: H.M. Stationery Office.)
- Cape Astrographic Zones. Vol. 8: Catalogue of Rectangular Coordinates and Diameters of Star-Images derived from Photographs taken at the Royal Observatory, Cape of Good Hope. Commenced under the Direction of Sir David Gill; Completed and Prepared for Press under the Supervision of S. S. Hough. Zone -48°. Pp. xlv+497. (London: H.M. Stationery Office.) 110s. net.
- Observations of Stellar Parallax from Photographs taken and Measured at the Royal Observatory, Greenwich, in the Years 1913-1924. Under the Direction of Sir Frank Dyson. Pp. xix+184+8. (London: H.M. Stationery Office.) 24s. net.
- Astronomical and Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the Year 1923. Under the Direction of Sir Frank Dyson. Pp. 8+Avx+A54+iv+B16+C2+Dix+D41+5+Exvii+E74+20. (London: H.M. Stationery Office.) 32s. 6d. net.
- University College of Wales, Aberystwyth: Agricultural Department. Advisory Bulletin No. 1. Seeds Mixture Experiments in West and Central Wales, 1915-1925. Pp. 64. (Aberystwyth.) 6d.
- British Museum (Natural History). Christmas Booklets. B93: The Rabbit. Pp. 2+1 plate. B93: The Stoat, or Ermine. Pp. 2+1 plate. B100: The Fox. Pp. 2+1 plate. C98: The Robin. Pp. 2+1 plate. (London: British Museum (Natural History)) 6d. each.
- Scientific and Industrial Research Council of Alberta. Report No. 14. Analyses of Alberta Coal. By Edgar Stansfield, Robert T. Hollies, and William P. Campbell. Pp. 64. (Edmonton, Alta.: J. W. Jeffery.) 25 cents.
- Proceedings of the Cambridge Philosophical Society. Vol. 22, Part 6, November. Pp. 817-978. (Cambridge: At the University Press.) 7s. 6d. net.
- Transactions of the Royal Society of Edinburgh. Vol. 54, Part 2, No. 3: Size in relation to Internal Morphology. No. 11: The Vascular System of Selaginella. By Claude W. Wardlaw. Pp. 281-308. 8s. 6d. Vol. 54, Part 2, No. 4: A Monograph on the General Morphology of the Myxinoïd Fishes, based on a Study of Myxine. Part vi.: The Morphology of the Vascular System. By Prof. F. J. Cole. Pp. 809-842+5 plates. 6s. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Diary of Societies.

TUESDAY, DECEMBER 29

ROYAL INSTITUTION OF GREAT BRITAIN, at 8.—Sir William Bragg: Old Trades and New Knowledge: (1) The Trade of the Sailor.

THURSDAY, DECEMBER 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 8.—Sir William Bragg: Old Trades and New Knowledge. (2) The Trade of the Smith.

FRIDAY, JANUARY 1.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—E. Cuzner: Stereo-Photomicrography.

JUNIOR INSTITUTION OF ENGINEERS (at 39 Victoria Street), at 7.30.—The Manufacture of Ordnance and the Rolling Mills and Crucible Melting Department at the River Don Works of Vickers, Ltd. (Cinematograph Lecture)

SATURDAY, JANUARY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 8.—Sir William Bragg: Old Trades and New Knowledge. (3) The Trade of the Weaver.